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ABSTRACT

This report presents the requirements and plans for providing public telecommunications services for the city of Columbus. Included are a description and analysis of potential applications of public telecommunications services in the community: the design requirements and system specifications for a two-way cable interconnect linking a government telecommunications facility with each of the four cable system headends; the construction, installation, and test specifications for the interconnect system; an implementation plan and schedule for procurement and construction of the system; an estimate of the cost to construct the system; and a 5-year facilities plan for construction, operation, maintenance, and program production for the government telecommunications facility. The appendices include recommendations for public telecommunication policy structure in Columbus and construction, installation, and test specifications. (CHC)

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FINAL REPORT

on

DEVELOPMENT OF PLANS FOR PROVIDING PUBLIC TELECOMMUNICATIONS SERVICES FOR THE CITY OF COLUMBUS, OHIO

to

DEPARTMENT OF ENERGY AND TELECOMMUNICATION,
CITY OF COLUMBUS

by

GIRARD W. LEVY and CARL J. BLOCH
Battelle Columbus Laboratories
PATRICK J. BIRNEY and LAWRENCE C. BROWN
Cable Link Engineering
THOMAS A. MUTH
East Lansing Research Associates

November, 1980

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PUBLIC TELECOMMUNICATIONS SERVICES
FOR THE CITY OF COLUMBUS, OHIO

to

DEPARTMENT OF ENERGY AND TELECOMMUNICATION,
CITY OF COLUMBUS

SUMMARY

The purpose of the study reported herein was to investigate the feasibility and cost of interconnecting the four cable systems serving the Columbus, Ohio metropolitan area, and if feasible, to develop plans for interconnection based on the most cost effective approach. Previous work (reported in an interim report) consisted of a study of local needs, the design of alternative systems capable of meeting these needs, and an evaluation of each alternative. The most cost effective alternative was found to be a two-way cable interconnect linking a government telecommunications facility with each of the four cable system headends.

This report presents:

- a description and analysis of potential applications of public telecommunications services in the community
- the design requirements and system specifications for the cable interconnect system
- the construction, installation and test specifications for the interconnect system
- an implementation plan and schedule for procurement and construction of the interconnect system
- the estimated costs to construct the interconnect system
- a five-year facilities plan for construction, operation, maintenance and program production for the government telecommunications facility.

Potential applications of public telecommunications services were derived from a survey of local needs of governmental, educational, cultural, and social service organizations in the Columbus, Ohio area. The potential applications were categorized into 34 categories of governmental, social service and public access use. System requirements for each category of application were defined. The applications of public telecommunications services identified in the Columbus area were generally the same as those suggested for other communities.

The cable interconnect system design requirements were developed to meet local needs of high priority. The purpose of the interconnect is to enable government, educational, cultural, and social service organizations in the community to more effectively communicate with and extend services to the public.

The interconnect system would involve approximately 20 miles of coaxial cable to connect each cable system headend with a government telecommunications center (GTC) located in the downtown area. Frequency modulated video signals would be utilized on the interconnect to provide high quality signal reception at the headends. The single cable interconnect would be configured with a bi-directional mid-split technique, providing both inbound and outbound channels on the same trunk. The interconnect system would also use available spectrum on the City's proposed traffic control system. This would be used as a government institutional channel and to transmit to the GTC programs originating at various remote points in the metropolitan area.

The GTC would be the focal point for the distribution of programs on the three downstream access channels provided by each of the four local cable operators. Program material originating at the GTC or received by the GTC would be converted to an outbound channel on the interconnect cable for distribution to the cable system headends. The cable systems would then distribute the programs to their subscribers. In order to accomplish this, interface equipment for modulating, demodulating and switching signals would be required at each headend, at each remote site, and at the GTC.

It is recommended that the City of Columbus' Department of Energy and Telecommunication be responsible for the construction and maintenance of the cable interconnect system. The Department of Energy and Telecommunication should also be responsible for scheduling and arranging for governmental uses of the cable interconnect, and for monitoring program content and use of the access channels. The scheduling of public access programming is best left to an independent public organization or non-profit corporation.

The implementation plan for the cable interconnect system describes the tasks or activities required to procure and construct the interconnect, together with the estimated time and responsibility for each task. The schedule for all tasks encompasses 52 weeks. It is recommended that a qualified systems engineer consultant be assigned full-time to this project by the City. The professional, independent objectivity of this approach will aid the City in selecting the best vendors and contractors for construction of the interconnect.

The overall interconnect system will cost approximately $511,000, including cable installation, interface equipment, master control equipment and spare parts. Funding should be sought from a variety of sources (Federal grants, City funds, and charitable foundations).

The facilities plan for operation, maintenance, and program production for the GTC was designed to provide a fairly uniform growth in capability over the first five years. The first year of development would be dedicated to the construction of the cable interconnect system, hiring of staff, purchase and installation of equipment, and acquisition and refurbishment of facilities space.

The analysis of the production requirements over a five-year period suggests that one production team of 7 people would be adequate to support the governmental production requirements. In addition to the production team, administrative and clerical personnel would be required to manage the GTC activities, interface with the various government, institutional, and public sectors which may wish to utilize the broadband communications capabilities, and schedule the production and telecasting of events. Finally, two maintenance technicians would be required to service

the production, master control, and cable distribution plant. This would bring the total personnel requirements to 14 people by the end of five years. At that time, annual personnel costs, including fringe benefits, will be approximately $313,000.

Construction of the cable interconnect system will provide the Columbus metropolitan area with a modern, flexible, broadband communications system capable of satisfying the needs of governmental, educational, cultural, recreational and social service organizations to communicate with and extend services to the citizens of the area.

1.0 INTRODUCTION

This report presents the detailed requirements and plans for providing public telecommunications services for the City of Columbus. Previous work (described in the Interim Report) consisted of a study of local needs and uses for public telecommunications facilities, an analysis of alternative systems for meeting local needs, and an evaluation of the alternative systems.

The study of local needs and uses involved a review of the literature on governmental, educational, and public uses of telecommunications services; the identification of local needs and uses; a review of barriers to public access; and a definition of service requirements for the various categories of use.

The analysis of alternative systems started with the delineation of six models capable of interconnecting the four CATV systems and capable of meeting the service requirements for the various categories of use. The analysis compared the relative capabilities of each alternative with their costs of implementation. The costs developed in the Interim Report and summarized below represent the basic costs of the interconnection network alternatives. These estimates were intended to provide a comparison between the interconnection alternatives, and as such, did not include the costs of master control, production facilities or staffing, which are common to all interconnection approaches. The estimates for these additional costs are included in Sections 5.0 and 6.0 of this report. The six interconnect models were:

Model 1. Utilization of available spectrum on the City's Division of Traffic Engineering and Parking coaxial cable communications system (3 channels inbound and 3 channels outbound on each of 6 spokes). Cost for this model was approximately $170,000.

Model 2. Utilization of the traffic control cable system, plus separate overlashed cable. (The separate overlashed cable is used to send FM video to the CATV headends.) In one variation (2a.) of this model, Coaxial Communications and All American Cablevision headends are served by the same trunk line. The approximate cost for this approach was $260,000. In another variation (2b.) of this model, a separate trunk line is provided for each headend. The approximate cost for this approach was $280,000.

Model 3. Providing a LDS (local distribution service) microwave link to each headend (3 channels outbound and one return, plus one return from a mobile van). Cost for this model was between $380,000 and $450,000.

Model 4. Similar to Model 3, but using an ITFS (instructional television, fixed service) microwave link to each headend. Cost for this model was between $360,000 and $430,000.

Model 5. "Bicycling" of tapes to each of the four headends. This approach would not support the service requirements for many of the potential uses. The approximate cost for this approach was $160,000.

Model 6. Construction of an independent cable interconnect. Cost for this model was approximately $415,000.

Five of the six models would support most of the applications. Only Models 2 and 6 were capable of supporting the high priority applications, and of providing for scheduling flexibility and future growth. On the basis of local need, ability to accommodate existing and future needs, and on the basis of cost of implementation, the project team

recommended Model 2b as the best choice for interconnecting the four systems. This model depends on the availability of the traffic control cable system. If this system is not implemented or if the required channel capacity is not made available, then Model 6 offers the next best interconnect approach (but at a significantly higher cost.) Either of the two approaches recommended will provide the Columbus metropolitan area with a high-quality broadband communications facility capable of offering governmental, social service and public access programming.

The present report begins with an overview of public telecommunications in Columbus, Ohio. Then, the potential applications for public telecommunications are described. The next sections present in detail the design concept for the interconnect system, the implementation plan for construction of the interconnect, and the facilities plan for public telecommunications. Each of these topics is presented in a separate section below.

2.0 OVERVIEW OF PUBLIC TELECOMMUNICATIONS IN COLUMBUS, OHIO

2.1 Current Situation

Franklin County, Ohio contains the City of Columbus, 25 other municipalities, together with several incorporated and unincorporated areas. The population of the county is nearly 1 million persons. The county has approximately 300,000 residences and 17,000 commercial locations.

The Columbus, Ohio metropolitan area is currently served by four independent CATV systems (All American Cablevision, Coaxial Communications, Warner Cable, and KBLE, a locally-owned minority company). These companies have franchises to operate cable communications systems in the City of Columbus under requirements set forth in Chapter 595 of the Columbus City Code. The Department of Energy and Telecommunication is responsible for enforcement of Chapter 595, and for the administration and development of cable communications in Columbus. All American Cablevision, Coaxial Communications and Warner Cable also have franchises to operate in the other municipalities and unincorporated areas within Franklin County. Cable saturation (percentage of homes passed) in the metropolitan area is approximately 83 percent, and penetration (percentage of homes subscribing) is approximately 40 percent.

The franchise agreements with each CATV operator provide for three governmental channels, including one shared with public access, plus one upstream governmental channel. In this report, these channels are referred to as "access channels". The CATV operators must also allow the City to interconnect the systems.

The Mayor of the City of Columbus has appointed a nine-member Cable Television Advisory Commission to monitor and review cable developments, and to advise the Mayor, the Department of Energy and Telecommunication, and the City Council concerning cable television issues.

In addition, a non-profit corporation, Columbus Community Cable Access, Incorporated, has been formed to promote and foster public use of cable television. The corporation may assume the task of scheduling public access programming.

2.2 Administrative Issues

2.2.1 Funding of the Interconnect

Funding for construction of the interconnect can come from a variety of sources: Federal grants, cable franchise fees, and charitable foundations. Funding for maintenance of the system can come from cable franchise fees, foundations, and contributions from users of the interconnect. Municipalities other than Columbus can also be asked to contribute a proportional amount for construction and maintenance of the system.

2.2.2 Administrative Control

The City of Columbus' Department of Energy and Telecommunication should be responsible for the construction and maintenance of the cable interconnect system. In order to avoid duplication of personnel and equipment, an agreement should be reached with the Division of Traffic Engineering regarding maintenance of that portion of the system that is overlashed to the traffic control cable.

The Department of Energy and Telecommunication should be responsible for scheduling the governmental programs on the interconnect. Columbus Community Cable Access, Inc., should be responsible for scheduling the public access programs on the interconnect. The justification for these policy recommendations is presented in Appendix A.

The Department of Energy and Telecommunication should be responsible for monitoring the program content (government and public access) on the interconnect. To properly perform this function, one or

more tuneable receivers should be provided in the master control area of the Government Telecommunications Center (GTC).

The provision of access channels is contractual right, not a service provided by the CATV operators. As such, government and public access is not synonomous with local noncommercial productions, where the CATV operator exercises editorial control over the content or scheduling of the programs. With regard to public access, the City of Columbus (and the other franchisers) provide the channel capacity. The scheduling of public access programming is best left to an independent public organization or corporation. Program content (particularly with regard to obscenity, libel, and invasion of privacy, etc.) is the ultimate responsibility of the program's sponsor (i.e., the person who formally requests public access cable time) and the program's producer.*

* In its recent order (FCC80-608, November 4, 1980) the Federal Communications Commission has not delineated policies to be followed in this area. The extent of responsibility of the CATV operator, the franchiser, and non-profit corporation scheduling public access programs is not settled.

3.0 POTENTIAL APPLICATIONS FOR PUBLIC TELECOMMUNICATIONS

3.1 Local Needs and Uses

A survey of local needs for public telecommunications services was conducted in association with the Cable Communication Forum, held in Columbus, Ohio, on October 22, 1979. The purpose of the survey was to determine the experiences and needs of the Columbus metropolitan area concerning the use of television for communication, public service, social service, and education.

A short survey form was prepared and mailed to local organizations, together with an invitation to participate in the forum. The survey solicited information on:

- types of communications currently produced
- use of public access cable capabilities
- evaluation of use
- reasons for not using the public access cable capabilities
- interest in producing programs for public access on cable television
- existence of production facilities and trained staff
- future plan for use of television.

One hundred nineteen organizations responded. These organizations included social service agencies in the Columbus metropolitan area, local chapters of national health and service organizations, local and state governmental organizations, educational entities, cultural organizations, religious organizations, and private communications firms.

Eighty percent of the organizations had not used the local public access capability. Eighty-seven percent, however, were interested in producing programs.

The results of the survey and the participation at the Cable Communications Forum, which exceeded expectations, clearly indicated a local need and interest in public telecommunications in the Columbus area.

In order to better define the kinds of applications that local organizations would like to make of public access cable capabilities, a variety of organizations were contacted. These organizations represent a cross-section of the social, cultural, religious, and educational organizations in the Columbus area. Detailed information on each organization's interest and plans for using cable was collected during a brief interview with one or two key individuals in each organization.

The planned uses were described by the organizations. These uses were subsequently grouped into categories of application with similar requirements. That is, uses which involved different contents or purposes were grouped together if they could be provided by the same system.

3.2 Categories of Application

Table 3.1 lists the categories of potential application which were derived from the stated needs and planned uses by local organizations. In most cases, after an organization had defined a general application, the project team determined its essential features, and then, the appropriate mechanization.

Basically, the applications of public telecommunications services identified in the Columbus area are the same as those postulated in national studies or suggested for other communities. This result was expected, and is partially due to the widespread dissemination of the ideas, concepts, and predictions of other authors. It is also due to a commonality of needs in urban areas.

A brief discussion of each application is presented below. A further discussion of the hardware and personnel requirements for each application is presented in Section 6.0.

Application 1. Local government meetings

This application encompasses Columbus and suburban/county governmental and quasi-governmental meetings cablecast live to the public.

TABLE 3.1 APPLICATIONS FOR PUBLIC TELECOMMUNICATIONS

A. Governmental Uses

1. Local government meetings
2. Local government reports and programs
3. Local government messages and announcements
4. Personnel training for local government
5. Descriptions of services and procedures
6. Emergency communications to the public
7. Intragovernmental conferences
8. Interoffice mail
9. Court, police uses
10. Interactive town meetings
11. Public transit schedules, tax information, office hours
12. Announcements with frequent updating
13. Police car location
14. Traffic signal control
15. Traffic monitoring and control
16. Public building resource monitoring
17. Public building resource management
18. Gas, water and electric meter reading
19. Water station monitoring and control
20. County-wide emergency call system

TABLE 3.1 APPLICATIONS FOR PUBLIC TELECOMMUNICATIONS (Continued)

B.	Social Service Uses
	21. Public service announcements
	22. Public service programs
	23. Institutional programs
	24. Library information
	25. Instructional programs to homes
	26. Instructional programs to schools and other institutions
	27. Credit courses
	28. Programs for special groups
	29. Instructional programs with an interactive component
	30. Community calendar
C.	Public Access Uses
	31. Local productions
	32. Live events
	33. Political candidates/ballot issues
	34. Individual appearances

Council meetings, school board meetings, panels, planning and zoning board meetings, commission meetings, and trials are among the possible events. The meeting may occur at the government telecommunications center (GTC) or at suburban/county government locations.

Application 2. Local government reports and programs

This application involves taped programs on community activities, local government programs, and reports to the public. The tapes will be played at the GTC.

Application 3. Local government messages and announcements

This application involves the presentation of brief, textual messages concerning forthcoming government meetings, announcements of general interest and requests for public input on special issues. Prepared text would be brought to the GTC for conversion to character generated text.

Application 4. Personnel training for local government

The application encompasses the cablecast of taped instructional programs for training governmental personnel (e.g., police, fire, finance, etc.). Instructional and recreational programs for jail or workhouse inmates may also be provided. Originating at the GTC, the programs will be cablecast to police and fire stations, governmental offices, jails, etc.

Application 5. Descriptions of Services and Procedures

This application involves the provision of textual and graphic information concerning government and legal services (e.g., procedures for voter registration, filing small claims, consumer fraud, special licensing,

tax payments, changing assessments, etc.) to the public. The text and diagrams are converted to digital form and inserted into the unused part of the video signal. The user, with a specially equipped terminal, selects the specific information he or she desires. Prepared text and simple diagrams would be brought to the GTC for conversion to videotext.

Application 6. Emergency communications to the public

This application involves the cablecasting of special messages to the public concerning major problems or emergencies affecting the metropolitan area. Live communication to the public by responsible officials would originate either at the GTC or from a remote location.

Application 7. Intragovernmental conferences

This application involves live two-way communication between selected stations for the purpose of providing visual and audio exchange (i.e., teleconferencing). Each station would be equipped to control transmission and reception with other stations. Stations would be set up at a centralized location, and a number of remote governmental office locations throughout the county.

Application 8. Interoffice mail

This application involves facsimile units and computer terminals in various governmental offices and other locations, with a minicomputer to store and forward mail and other intragovernmental communications.

Application 9. Court, police uses

This application involves live point-to-point video communications (private) for such uses as preliminary arraignments, depositions, bail hearings, police line-ups, filing of legal motions, etc. Live

programs and presentations to police or fire stations are also a possible use.

Application 10. Interactive town meetings

This application extends Application 1, by providing feedback from viewers via the interactive cable system. The feedback (in digital form) in response to questions posed during a meeting would be tabulated by computer and made available during the meeting. This application allows for public participation, decision-making, and comment on the issues. In order to provide for the broadest participation from all sectors of the public, interactive terminals would be set up in high schools, senior centers, recreational centers, hospitals, etc.

Application 11. Public transit schedules, tax information, office hours

This application encompasses the provision of fixed, detailed, textual information to the public. The videotext system would be used to satisfy this requirement (see Application 5).

Application 12. Announcements with frequent updating

This application, similar to Application 3, involves the use of character generated text with frequent updates to announce traffic conditions, storm warnings, etc.

Application 13. Police car location

This application involves the use of transmitters in cars, and the traffic cable system to identify the approximate location of police vehicles. This information is made available to the police dispatcher.

Application 14. Traffic signal control

This application involves the use of the CATV cable systems and the city's traffic computer to control traffic signals.

Application 15. Traffic monitoring and control

This application involves monitoring traffic flow at selected intersections (via TV) and remotely controlling the signals. This application was the subject of a detailed analysis and report by Battelle.

Application 16. Public building resource monitoring

This application involves reading gas, water and electric usage in public buildings, and transmitting this information via cable to a central computer that would store and analyze the data.

Application 17. Public building resource management

This application extends Application 16 by providing the capability to centrally control the usage of resources in public buildings (e.g., turning down heat or air conditioning). Manual overrides for limited time periods would be provided.

Application 18. Gas, water and electric meter reading (homes and businesses)

This application involves the remote reading of gas, water and electric meters and transmitting this information via the CATV systems to a central computer for storage, billing and analysis.

Application 19. Water station monitoring and control

This application involves monitoring (via digital signals) the status of city water stations and remotely controlling water station actions.

Application 20. County-wide emergency call system

This application involves monitoring (in near real time) alarm sensors in homes, businesses and public buildings; discriminating the nature of the alarm (police, fire, medical emergency, etc.); automatic telephone dialing to verify the signal; and routing of validated signals to the appropriate agency.

Application 21. Public service announcements

This application encompasses brief prerecorded announcements for public, nonprofit organizations. The announcements may be informational or educational in nature. Video tapes would be brought to the GTC for cable transmission to all subscribers.

Application 22. Public service programs

This application encompasses longer video programs sponsored by public, nonprofit organizations. Taped programs would be transmitted from the GTC to all subscribers.

Application 23. Institutional programs

This application encompasses programs produced and/or sponsored by local institutions (libraries, museums, art galleries, hospitals, schools, etc.). The programs, either live or taped, would likely originate at remote locations (i.e., the sponsoring institutions themselves), and would be available to all subscribers.

Application 24. Library information

This application involves textual library information (catalog listings, reference materials) stored at the public library and transmitted to homes via cable. An interactive system is envisioned, in which the users requests data which are transmitted to specially equipped terminals. A videotext system could not handle the large quantity of data available.

Application 25. Instructional programs to homes

This application involves taped instructional and educational programming for elementary, secondary, post-secondary, college or general adult learners. The taped programs would originate at the GTC and be sent to all subscribers.

Application 26. Instructional programs to schools and other institutions

This application involves live or taped instructional and educational programming directed to schools, hospitals, senior centers, public nursing homes, recreational centers, jails, etc. The live programs would likely originate at remote locations (studios in schools, hospitals, etc.). Tapes would be brought to the GTC for cablecasting.

Application 27. Credit courses

This application involves live or taped instructional programming that can be received by all cable subscribers. A fee could be charged for receipt of related textual material and/or for registration and course credit. The educational institutions should arrange with the CATV operators for a channel(s) for this educational programming. The CATV operators may desire to present the offerings as part of their subscription package. Nevertheless, an interconnect channel would be used to pass the program from one (originating) CATV headend to the other three CATV headends for simultaneous cablecasting on all four systems.

Application 28. Programs for special groups

This application encompasses taped programs of an educational or recreational nature designed for special groups (e.g., elderly, bed-ridden, handicapped, shut-ins). The programs would be sent to homes and community institutions (hospitals, senior centers, recreational centers, public nursing homes). The programs would be transmitted from the GTC to specially equipped receivers.

Application 29. Instructional programs with an interactive component

This application extends Applications 26 and 27 to provide for the use of feedback from the viewer. The viewer could then ask questions, answer questions, and take examinations using the two-way cable system.

Application 30. Community calendar

This application is similar to Application 3, but encompasses public, social service, and non-governmental information. Prepared text would be brought to the GTC for conversion to character generated text.

Application 31. Local productions

This application encompasses locally produced films and video-tapes, or taped programming of high local relevance. Video tapes would be brought to the GTC for cable transmission to all subscribers.

Application 32. Live events

This application encompasses locally produced programs involving educational, cultural, or recreational events. Programs would be taped for later replay. This programming would originate at CATV studies or remote locations.

Application 33. Political candidates/ballot issues

This application, a part of public access programming, encompasses provision of time for local political candidates to appear, or for individuals to address local ballot issues. Programs may be live or taped, and would likely originate at one of the CATV studios.

Application 34. Individual appearances

This application encompasses provision of time for individuals to appear and speak or present material on any subject of their choosing. Programs would be live and would likely originate at one of the CATV studios.

3.3 System Requirements

Table 3.2 presents the system characteristics and requirements for each of the applications identified in Table 3.1. For each application, the following system requirements were defined:

- Characteristics of the Transmission
  - Live (L), Delayed (D), or Either (E)
  - Continuous (C) or Sampled (S) transmission
  - Frequency of Events (per month)
  - Duration of Event (hours)
  - Repetition (per program)
  - Utilization (total hours per month)
  - Channel Utilization (hours per month)
- Event Origination
  - Government Telecommunications Center (GTC) Studio
  - CATV Studio
  - Remote Location
  - Other (multi-point origination)

- Communication Type
  - TV Out
  - TV In
  - Data Out
  - Data In (T = telephone request)
  - Audio In and Out
- Communication Network Requirements
  - One to One (TV)
  - One to Many
  - Many to One (Digital)
  - Many to Many
  - Cablecast (C) or Narrowcast (N)
  - Service Level (I = widest possible dissemination;
    II = dissemination to specially equipped sets;
    D = digital information)
- Miscellaneous Requirements
  - Quality [High (H) = broadcast quality;
    Medium (M) = some degradation acceptable;
    Low (L) = digital signals]
  - Reliability [High, Medium or Low]
  - Security [Yes (Y), Privacy of Request (P) or
    No Security Required (N)].

For most applications, the program frequency, duration and repetition requirements had to be estimated from the nature of the application, the number of interested organizations (municipalities, agencies, etc.) and the nature of the audience. A high frequency of production and transmission cannot be expected immediately upon interconnection, but will build with time. However, there are clear indications that some applications (for example, government or library information services, instructional programs and politlcal candidates) will utilize a high number of hours per month almost from the start.

All the requirements listed in Table 3.2 have not been confirmed with the appropriate organizations. The level of utilization assumed was based on a moderate level of local familiarity with public access and a

moderate level of local production capability. It seems clear that increased levels of utilization could easily consume all of the available time on all three downstream channels. The greatest pressure appears to be at Service Level I (i.e., basic service applications).

TABLE 3.2. SYSTEM CHARACTERISTICS AND REQUIREMENTS FOR EACH APPLICATION

System Requirements	Applications 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Event Transmission															
Live/Delayed/Either	L	D	D	D	D	L	L	-	L	L	D	D	L	L	L
Continuous/Sampled	C	C	C/S	C	S	C	C	S	C	C	S	C/S	S	S	C/S
Frequency (Per Month)	10	5	84	5	5	.17	8	800	100	1	20	84	28	28	28
Duration (Hours)	2	1	.17	1	.25	.5	2	.03	1	2	.25	.08	24	24	24
Repetition (Per Program)	1	4	4	4	1000	1	1	1	1	1	100	16	1	1	1
Utilization (Hours/Month)	20	20	57	20	1250	.08	16	24	100	2	500	108	672	672	672
Channel Use (Hours/Month)	40[a]	20	57	20	0[b]	.16[a]	35[c]	4[d]	216[c]	2.2[e]	0[b]	0[b]	168[f]	0[g]	0[g]
Event Origination															
TC Studio	x	x	x	x	x	x	x			x	x	x			
CATV Studio										x					
Field Remote	x					x	x	x	x	x				x	x
Other													Distri-bution System	Office	Office
Communication Type															
TV Out	x	x	x	x	x	x	x		x	x	x	x			x
TV In	x					x	x		x	x					x
Data Out							x	x					x	x	x
Data In							x	x		x			x	x	x
Audio In/Out							x		x						
Communication Network															
One To One (TV)	In					In	In, Out	In	In, Out				Out	Out	
One To Many	Out	Out	Out	Out	Out	Out	Out,D	Out		Out	Out	Out			Out,D
Many To One (Digital)							In			In			In	In	In,TV
Many to Many							In, Out		In, Out						
Cable Cast/Narrow Cast	N	N	N	N	N	C	N	N	N	N	N	N	N	N	N
Service Level (I/II/D)	I	I	I	II	I	I	II	II	II	I	I	I	D	D	D + TV Return
Miscellaneous Requirements															
Quality (H/M/L)	H	H	M	M	M	M	M	L	H	H	L	L	L	L	L
Reliability (H/M/L)	M	L	L	L	L	H	M	M	M	M	L	L	M	M	M
Security (Y/P/N)	N	N	N	Y	P	N	Y	Y	Y	P	P	N	Y	Y	Y

TABLE 3.2. SYSTEM CHARACTERISTICS AND REQUIREMENTS FOR EACH APPLICATION (Continued)

System Requirements	Applications 16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
Event Transmission														
Live/Delayed/Either	L	L	L	L	L	D	D	E	D	D	E	E	D	L
Continuous/Sampled	S	S	S	S	S	C	C	C	S	C	C	C	C	C
Frequency (Per Month)	28	28	.3M	28	40K	50	20	4	100	20	20	20	8	20
Duration (Hours)	24	24	.05	24	1 min	.03	1	1	.5	1	1	1	1	1
Repetition (Per Program)	1	1	1	1	1	56	8	8	10	12	4	12	12	1
Utilization (Hours/Month)	672	672	15K	672	667	84	160	32	500	240	80	240	96	20
	112[h]	112[h]	.7[h]	.1[h]	448[h]	84	160	64[a]	0[b]	240	160[a]	240	96	47[c]
Event Origination														
TC Studio						x	x			x			x	
CATV Studio												x		
Field Remote								x	x		x			x
Other	Bldgs	Off./ Bldgs	Homes, Busi- nesses	Homes, Busi- nesses	Homes Boxes									
Communication Type														
TV Out						x	x	x	x	x	x	x	x	x
TV In								x	x		x			x
Data Out	x	x	x	x	x									
Data In	x	x	x	x	x									x or T
Audio In/Out														
Communication Network														
One To One (TV)								In	In		In			In
One To Many	Out,D	Out,D	Out,D	Out,D	Out,D	Out	Out	Out	Out	Out	Out	Out	Out	Out
Many To One (Digital)	In	In	In	In	In									In
Many To Many														
Cable Cast/Narrow Cast	-	N	-	-	N	C	C	C	N	C	N	N	N	N
Service Level	D	D	D	D	D	I	I	I	II	I	II	II	II	II
Miscellaneous Requirements														
Quality (H/M/L)	L	L	L	L	L	H	H	H	L	H	H	H	H	H
Reliability (H/M/L)	L	L	L	L	H	L	L	M	L	L	M	L	L	M
Security (Y/P/N/)	N	Y	P	P	Y & P	N	N	N	P	N	N	Y	N	Y & P

TABLE 3.2. SYSTEM CHARACTERISTICS AND REQUIREMENTS FOR EACH APPLICATION (Continued)

System Requirements	Applications 30.	31.	32.	33.	34.
Event Transmission					
Live/Delayed/Either	D	D	E	E	L
Continuous/Samples	C/S	C	C	C	C
Frequency (Per Month)	28	20	8	20	5
Duration (Hours)	.17	1	1	1	.5
Repetition (Per Program)	12	8	3	12	1
Utulization (Hours/Month)	57	160	24	240	2.5
Channel Use (Hours/Month)	57	160	48[a]	480[a]	5[a]
Event Origination					
TC Studio	x	x			
CATV Studio			x	x	x
Field Remote			x	x	
Other					
Communication Type					
TV Out	x	x	x	x	x
TV In			x	x	x
Data Out					
Data In					
Communication Network					
One To One (ITV)			In	In	
One To Many	Out	Out	Out	Out	Out
Many To One (Digital)					
Many To Many					
Cable Cast/Narrow Cast	C	C	C	C	C
Service Level (I/II/D)	I	I	I	I	I
Miscellaneous Requirements					
Quality (H/M/L)	M	H	H	H	H
Reliability (H/M/L)	L	L	M	M	M
Security (Y/P/N)	N	N	N	N	N

Footnotes appear on the following page.

Table 3.2 Notes

a - two video channels required

b - overlaid on other programming

c - two video channels plus digital required

d - digital only

e - one video channel plus digital required

f - narrow band communications required

g - provided by the Division of Traffic Control

h - two digital channels required

4.0 DESIGN CONCEPT FOR THE COAXIAL CABLE COMMUNICATIONS INTERCONNECT SYSTEM

4.1. Understanding the Requirements

The purpose of the Coaxial Cable Communications Interconnect is to provide a high-quality broadband communications network to support the City's Government Telecommunications Center. The Government Telecommunications Center and its broadband communications facilities enable the City and surrounding communities to more effectively communicate with and extend services to the public.

The project involves installing approximately 20 aerial miles of single cable plant construction to interconnect the QUBE, Coax, KBLE and All American headends to the City's Telecommunications Facility. The single cable interconnect will be configured with a bi-directional mid-split technique with 5-110 MH_z segment providing the inbound channels and 174-300 MH_z segment providing the outbound channels. FM modulated video signal techniques will be utilized on the Broadband Interconnect System. This form of transmission requires 14 MH_z of spectrum per channel. Using the 14 MH_z channels, the interconnect will provide at least three usable outbound channels in the 174-300 MH_z range, and at least one inbound channel in the 41-55 MH_z range. The interconnect system will also utilize available spectrum on the proposed City's Traffic Control System now being planned by the Division of Traffic Engineering and Parking. The Division of Traffic has allocated 18 MH_z in both the forward and reverse spectrum on its proposed Traffic Control Surveillance System for use by the Telecommunications Center. FM modulated video signal techniques will also be utilized on the Traffic Control System. This will

allow the capability of transmitting and receiving one high-grade video channel on the traffic system. The Traffic Control System capabilities (one video channel in each direction) will be used to transport programs originating at various remote points to the Telecommunications Center. These remote points of potential program origination include, but are not limited to:

> Fort Hayes, Columbus Public Library, COSI, Veterans Memorial, Franklin University, The Ohio State University, Ohio State Fair Grounds, Ohio Historical Society, etc.

Figure 4.1 depicts the conceptual architecture of the interconnect system.

The Telecommunications Center will be the focal point of the distribution of programs on the three access channels provided by each of the four local cable operators. Any program material received by the Telecommunications Center will be converted to an outbound channel on the telecommunication interconnect cable for distribution to the CATV headends. The cable operators will then distribute the programs to the subscribers.

In order to specify the design parameters for the Coaxial Cable Interconnect System in a more logical fashion, the interconnect design specifications will be detailed under two general categories. The first category ("Outside Distribution System Design Requirements and Specifications") will address only those components which are physically located outside the Telecommunications Center, cable company headends and remote programming site facilities. The second category ("Inside Interconnect Interface Component Design Requirements and Specifications") will address only those interconnect components which are physically located inside the Telecommunications Center, cable company headends and remote programming site facilities.

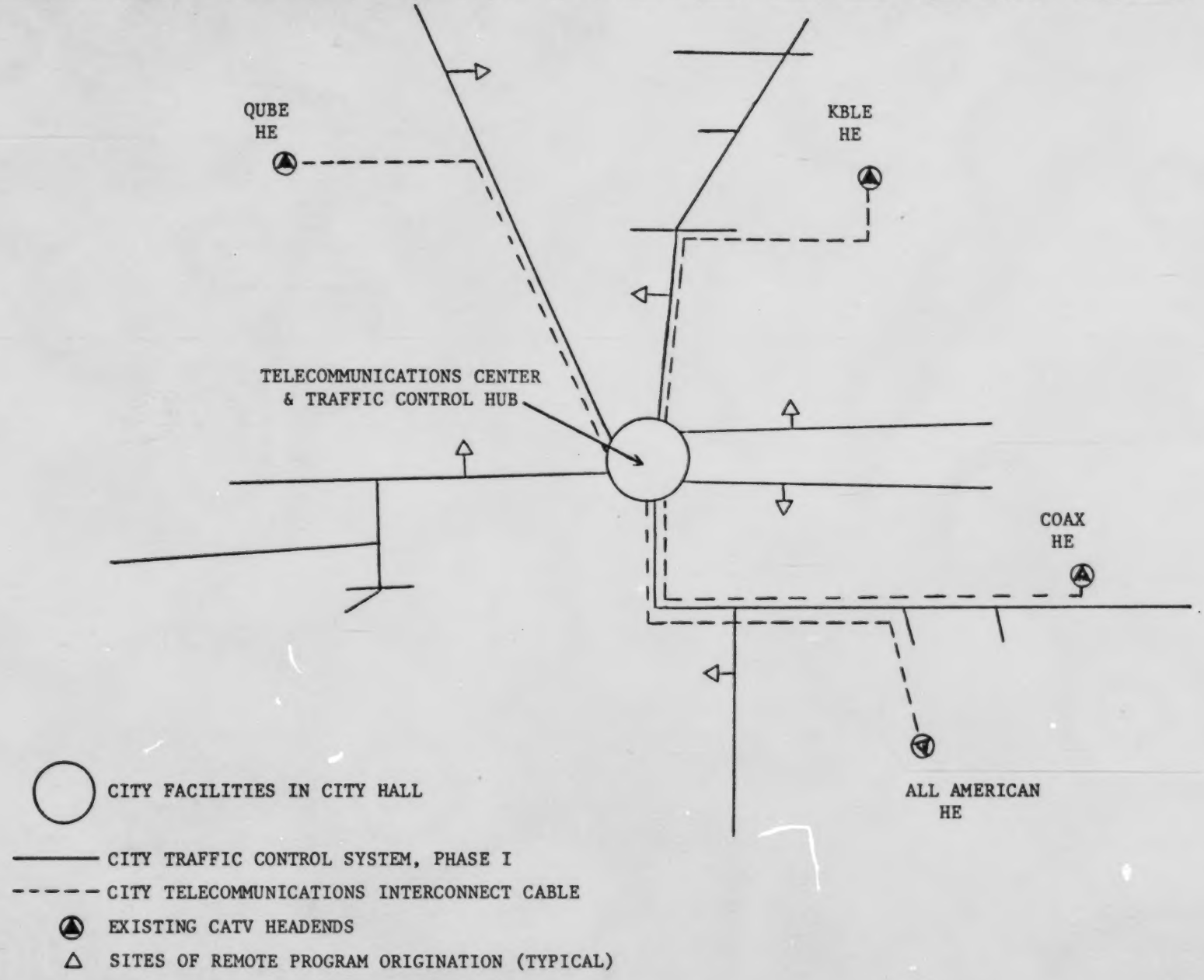


FIGURE 4.1. CONCEPTUAL ARCHITECTURE

4.2. Outside Distribution System Design and Specifications

This section sets forth the minimum technical, engineering, performance, installation and construction requirements which shall apply to the construction of the City's Outside Distribution Interconnect System.

4.2.1. General System Specifications

A. The system shall be bi-directional over a single coax cable. The system shall be of the type generally referred to as "single trunk" mid-split, coaxial system wherein the trunk cable shall carry outbound signals in the frequency range of 174-300 MHz and inbound signals in the frequency range of 5-110 MHz. The system shall provide for distribution of FM modulated television channels.

B. The outbound system shall provide for a minimum distribution of three (3) FM modulated television channels and pilot carriers in the 174-300 MHz region. The inbound system shall provide for a minimum distribution of one (1) FM modulated television channel and pilot carriers in the 5-110 MHz region.

C. The coaxial cable fittings and connectors shall have a characteristic impedance of 75 ohms (28 dB return loss). All connectors must use integral mandrel steel sleeves.

D. The System shall be designed for pilot carrier Automatic Slope/Level Control operation preferably using CW carrier frequencies.

E. Automatic Level Control amplifiers shall be placed at every trunk location.

F. Built-in test points shall be provided for system maintenance at input and output of trunk amplifiers.

G. All passive devices shall be rated to pass a continuance eight (8) amperes of AC current at 60V AC.

H. The System shall be operational between -40° and +140°F.

I. System layout shall be performed on strand maps furnished by the City of Columbus.

J. The System shall meet all applicable FCC regulations in effect at the signing of the contract.

4.2.2. Active Equipment Specifications

A. All equipment shall conform with all applicable requirements of good engineering practices for design, construction and shall be new, first quality, of the latest design, and free from defects and poor workmanship.

B. All active circuitry in the equipment used shall be fully transistorized. Fuses or circuit breakers shall be provided for protection of the equipment from damage due to overload. All RF ports should contain surge arrestors.

C. The equipment shall be remotely powered through the coaxial cable by means of regulated transformers. A suitable RF power line filter shall provide not less than 46 dB of RF attenuation on the AC path.

D. Equipment operating parameters will be established such that all specified System performance parameters will be met.

E. Equipment instruction manuals to be provided shall include schematics, parts lists, operating instructions, and maintenance instructions where applicable.

F. All amplifiers of the System shall operate with uniform output levels.

4.2.3. Cable Specifications (Fused Disc or Equivalent)

A. All coaxial cables used in the System shall have a nominal characteristic impedance of 75 ±2 ohms over the entire specified frequency range (5-400 MHz).

B. All cable in the System shall meet the following requirements, and shall be tested for return loss and attenuation at the factory, and on site. Prior to installation, City acceptance of cable must be obtained.

i. Trunk lines shall use .750" aluminum cable. Parallel trunk cables shall, wherever practical, be lashed together with tracer markings on each trunk cable.

ii. True structural return loss shall be 28 dB minimum from 5-400 MHz.

iii. Attenuation shall be based on the manufacturer's maximum rated loss in dB per 100 feet at 50, 300, and 400 MHz at a stabilized ambient temperature of 68°F.

C. For underground or buried applications, the cable shall be provided with a black high-molecular weight polyethylene jacket. A flooding compound shall be provided between the cable jacket and the aluminum sheath.

4.2.4. System Performance Specifications

A. Trunk Cable "Outbound" -- The following specifications are expected performance between any two self-contained points in the outbound trunk transportation system with carriage of 20 CW channels.

i. Gain vs Frequency Response (peak-to-valley) within the respective pass band, shall be no greater than 0.5 dB across any 6 MHz segment.

ii. The maximum overall excursion from ideal Gain vs Frequency Response (174-300 MHz) at any trunk amplifier station shall not exceed ±2 dB.

iii. The carrier-to-noise within a 4 MHz bandwidth at 75 ohms shall be 45 dB or better.

iv. The carrier-to-hum ratio shall be 0.5% or better.

v. Carrier-to-cross modulation ratio shall be 60 dB or better.

vi. Carrier-to-discrete intermodulation beat ratio components shall be equal to or better than 62 dB.

vii. Carrier-to-echo ratio shall be 40 dB or better.

viii. Differential group delay shall be less than 200 nano-seconds.

B. Trunk Cable "Inbound" -- The following specifications are expected performance between any two self-contained points in the trunk transportation system with carriage of 12 CW channels.

i. Gain vs Frequency Response (peak-to-valley) within the respective pass band, shall be no greater than 0.5 dB across any 6 MHz segment.

ii. The maximum overall excursion from ideal Gain vs Frequency Response (5-110 MHz) at any trunk amplifier station shall not exceed ±2 dB.

iii. The carrier-to-noise within a 4 MHz bandwidth at 75 ohms shall be 45 dB or better.

iv. The carrier-to-hum ratio shall be 0.5% or better.

v. Carrier-to-cross modulation ratio shall be 60 dB or better.

vi. Carrier-to-discrete intermodulation beat ratio components shall be equal to or better than 62 dB.

vii. Carrier-to-echo ratio shall be 40 dB or better.

viii. Differential group delay shall be less than 200 nano-seconds.

C. Additional System Specifications --

i. Power supplies shall have a minimum 12 amp capacity but shall have a maximum load of 85% of that capacity anywhere in the system. When loading the power supplies to 85% capacity, two-way amplifier station current ratings shall be utilized.

ii. All amplifiers shall be designed with a minimum of 2 dB reserve gain from the actual amplifiers' minimum full gain rating with a full equalizer complement.

iii. Maximum published passive insertion losses shall be used in the design of the system.

iv. Each power supply location shall be equipped with time delay relays installed on the output side to delay power turn-on after outages.

v. The system as designed, engineered, and installed shall meet or surpass all FCC radiation requirements in effect at the signing of the contract.

vi. The system shall have a carrier-to-ingress ratio of greater than 60 dB when the portion of the system under test is subjected to an RF field strength of .1 voltmeter by a half-wave dipole antenna located 12 feet off of the ground and 10 feet from the system.

Construction, installation and test specifications are presented in Appendix B.

4.3. Inside Interconnect Interface Component Design Requirements and Specifications

This section sets forth the minimum technical performance and design requirements which shall apply to the interface equipment used in the City's Telecommunications Service Network.

4.3.1. General System Requirements

The purpose of the interface equipment is to provide the necessary interface between the program origination and receiving points and the Coaxial Cable Network. FM modulators and demodulators are utilized to insure that the highest degree of picture quality is maintained as the signals are distributed throughout the Telecommunications Service Network.

Figure 4.2 depicts the overall block diagram of the Telecommunications System. This design is slightly modified from the design presented in the Interim Report. This design includes the GTC interface equipment required to communicate with remote sites on the traffic control cable and provides an additional outbound channel on the traffic control cable.

4.3.2 Telecommunications Center Interface Equipment Requirements

The primary requirements of the Telecommunications Center interface equipment are:

A. FM modulate up to three audio/video local origination television signals to the super band frequency spectrum for distribution on the Interconnect Cable Network.

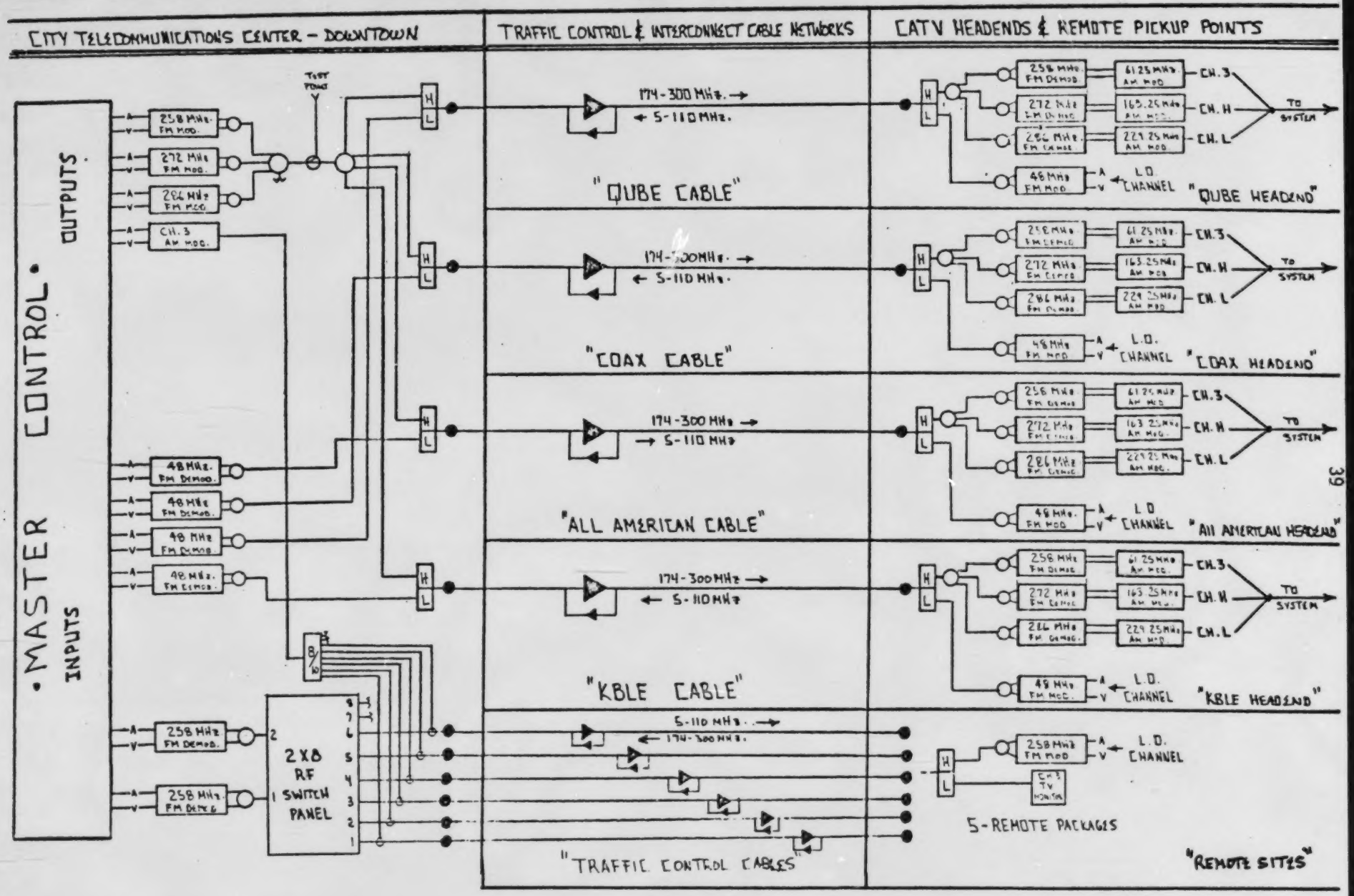


FIGURE 4.2. INTERCONNECT BLOCK DIAGRAM

B. Demodulate up to four FM-modulated television signals arriving from the local cable TV heads for processing and distribution on the interconnect network.

C. Demodulate up to two FM-modulated television signals arriving from various remote programming points along the Traffic Control System.

Figure 4.3 depicts the basic block diagram of the necessary equipment to provide these functions.

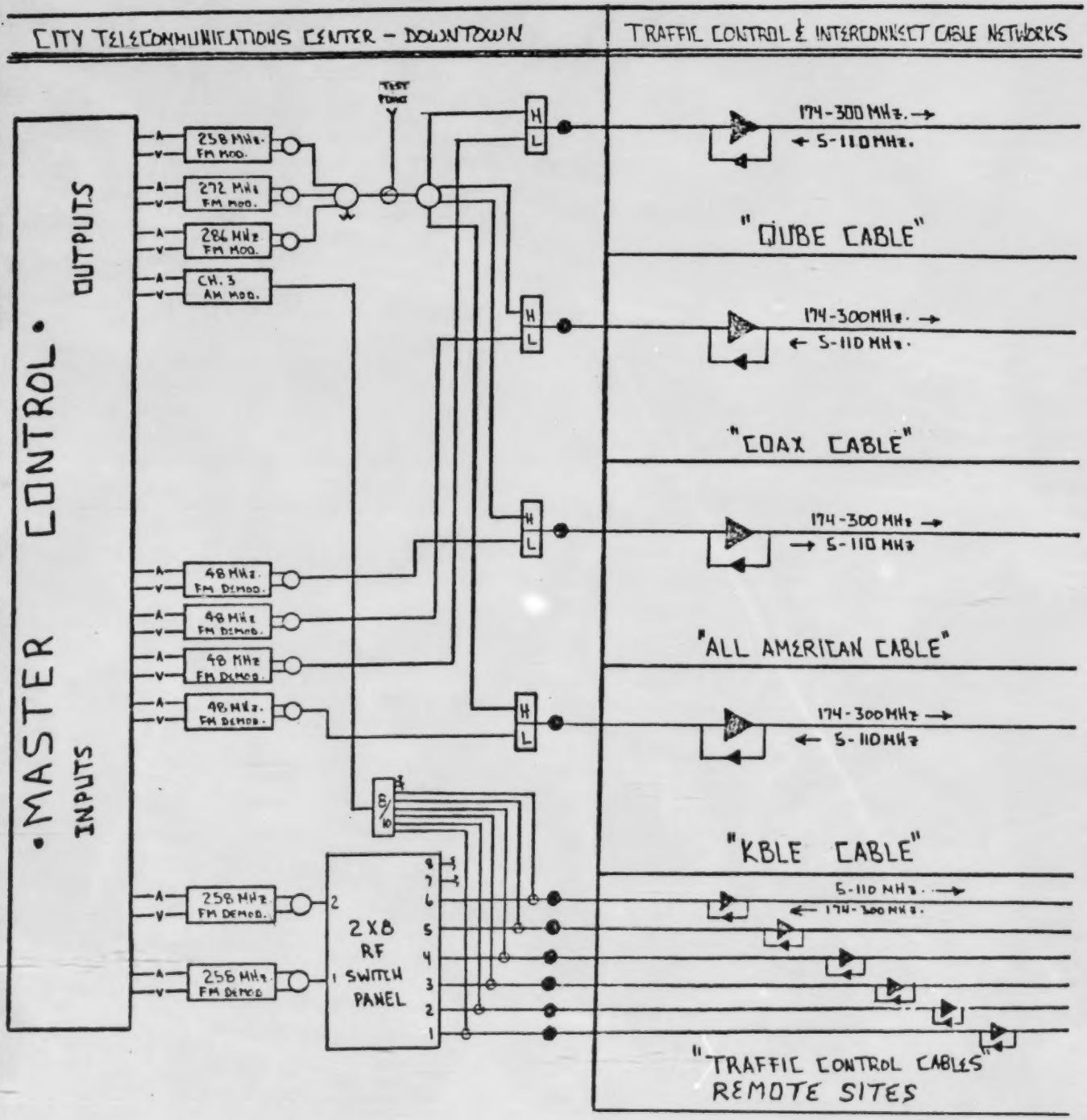


FIGURE 4.3. TELECOMMUNICATIONS CENTER INTERFACE EQUIPMENT BLOCK DIAGRAM

4.3.3. Cable TV Headend Interface Equipment Requirements

The primary requirements of the cable TV headend interface equipment are:

A. Demodulate up to three FM-modulated television channels arriving from the Telecommunications Service Center and modulate them to channels 3, H and L for distribution on the cable TV network.

B. FM modulate one audio/video local origination television signal to the VHF frequency spectrum for distribution back to the Telecommunications Center.

Figure 4.4 depicts the basic block diagram of the necessary equipment to provide these functions.

4.3.4. Remote Site Interface Equipment Requirements

The primary requirements of the remote site interface equipment are:

A. FM modulate one audio/video local origination television signal to the super band frequency spectrum for distrubution back to the Telecommunications Center.

B. Provide an AM-modulated test signal at the remote site to monitor the final signal leaving the Telecommunications Center.

Figure 4.5 depicts the basic block diagram of the necessary equipment to provide these functions.

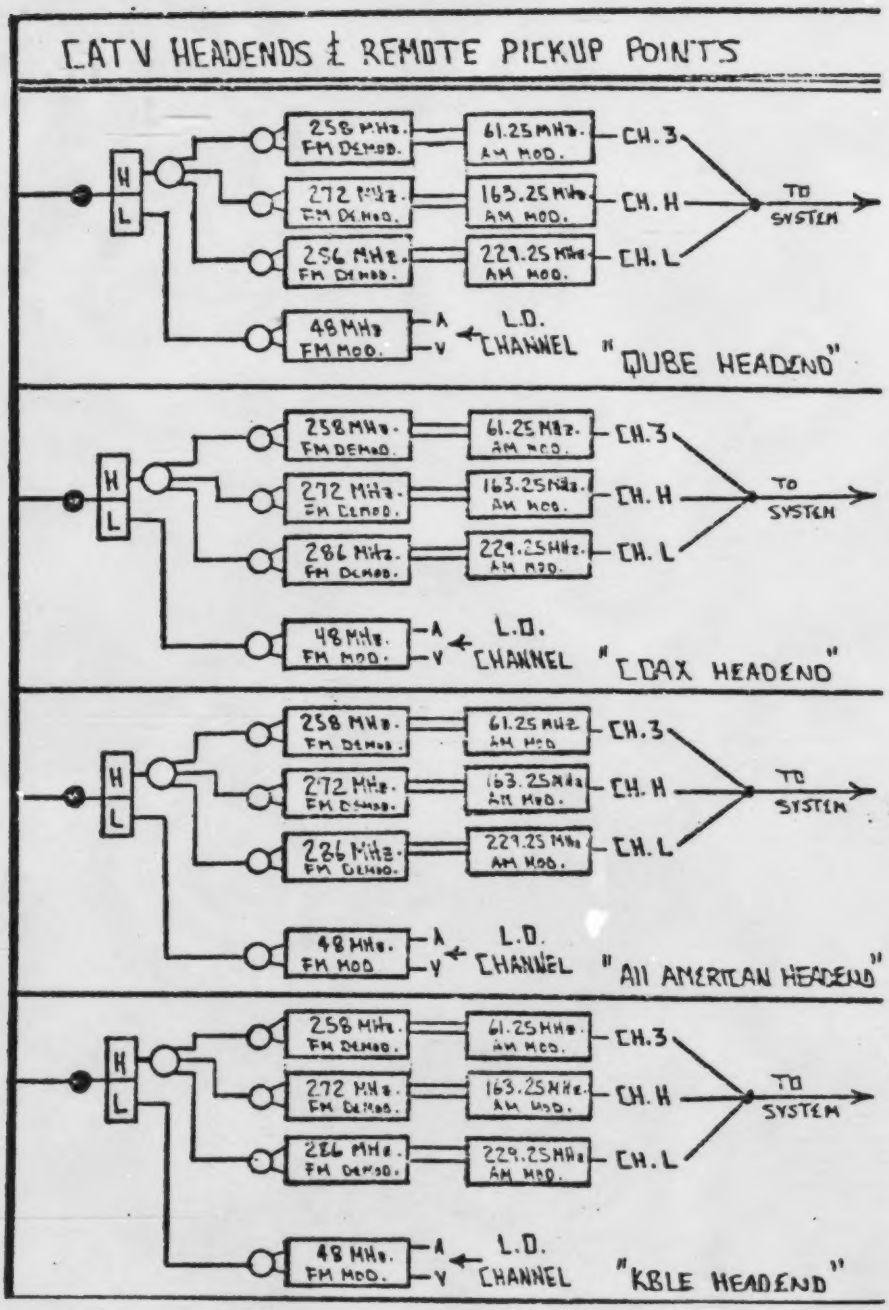


FIGURE 4.4. CABLE TV HEADEND INTERFACE EQUIPMENT BLOCK DIAGRAM

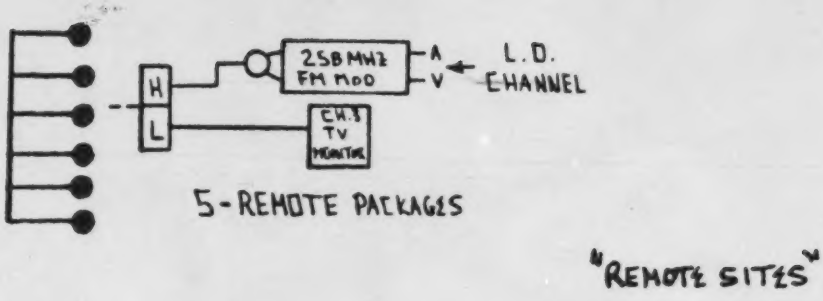


FIGURE 4.5. REMOTE SITE INTERFACE EQUIPMENT BLOCK DIAGRAM

4.3.5. Telecommunications Center Master Control Equipment Requirements

The primary requirements of the master control equipment is:

A. Monitor, switch and route the various video/audio signals to the three FM modulators for distribution on the interconnect network.

Figure 4.6 depicts the basic block diagram of the necessary equipment to provide this function.

4.3.6. Interface Equipment Specifications

The following specification sheets outline the basic technical specifications for the major pieces of equipment utilized in the inside interconnect interfaces.

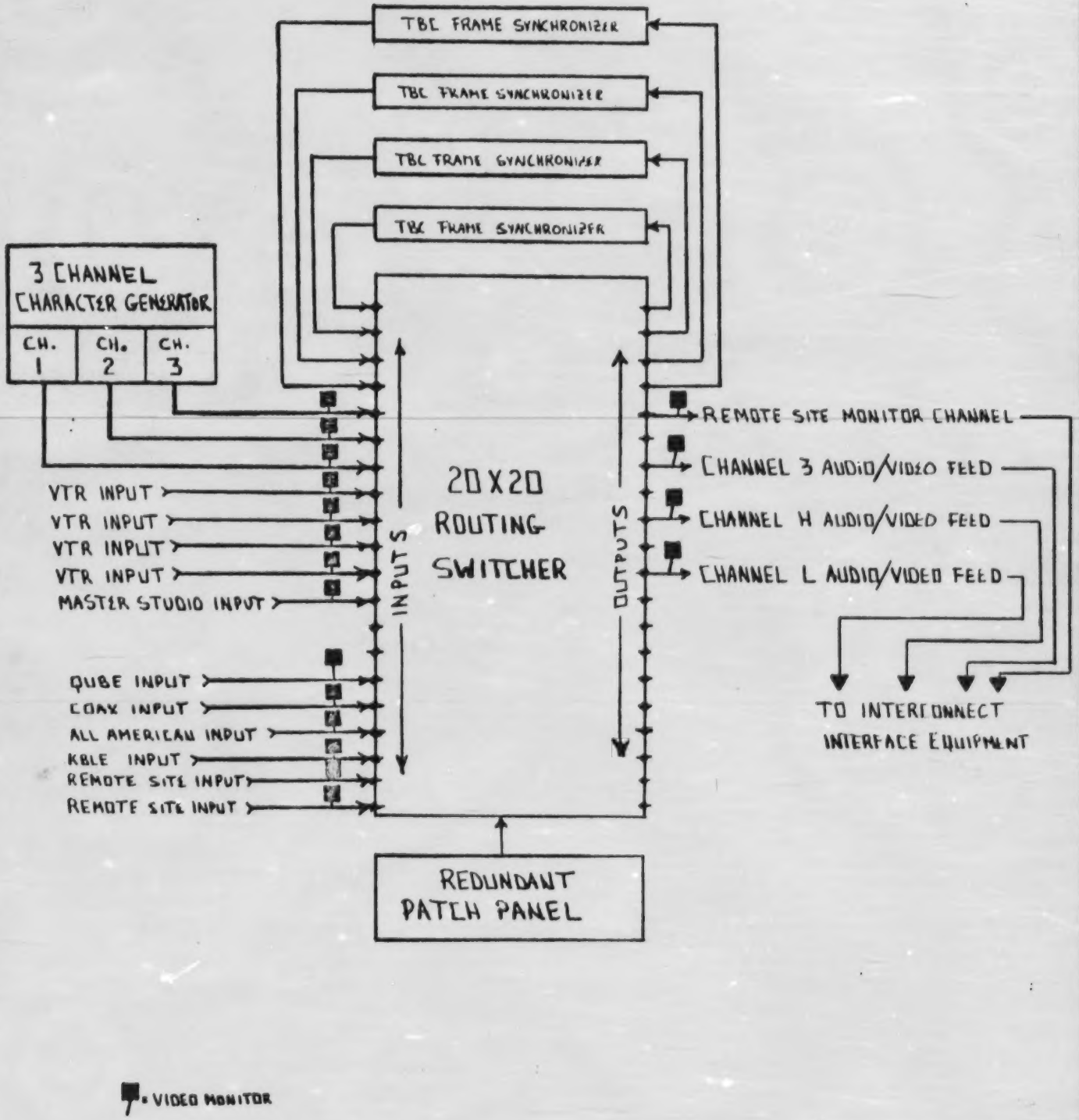


FIGURE 4.6. MASTER CONTROL BLOCK DIAGRAM.

FM MODULATOR & DEMODULATOR SPECIFICATIONS

SPECIFICATIONS

Video FM System

Frequency Range	19MHz, to 239 MHz — System (Specify)
Channel Bandwidth	14 MHz
Video Frequency Response	±0.5 dB 30 Hz to 4.2 MHz
Chrominance-Luminance Delay	±50 nsec (62-293 MHz Systems)
Differential Gain	±0.5 dB
Differential Phase	±2°, 3.58 MHz
Signal to Noise Ratio	60 dB Min. Back to Back (Unweighted) +15 dBmV Receive Level
Field Squarewave Tilt	2% Max.
Operating Temperature	+10 to +40°C, Ambient

Video FM Modulator

Input Level	1.0V Peak-Peak, (Adjustable)
Input Impedance	75 Ohm Unbalanced 20 dB Return Loss
Output Impedance	75 Ohm Unbalanced 16 dB Return Loss
Output Level	+54 dBmV, (Adjustable)
Frequency Stability	±0.1%
Spurious Output	Min. of 60 dB Below Peak Carrier Level Outside 14 MHz Bandwidth

Video FM Demodulator

Input Level	+10 dBmV Min. to +30 dBmV Max.
Input Impedance	75 Ohm Unbalanced 16 dB Return Loss
Output Level	1V Peak to Peak (Adjustable)
Output Impedance	75 Ohm Unbalanced 20 dB Return Loss

Power Supply

Input	105 to 125 VAC, 60 Hz, 60 Volt-Amps Max.
Outputs	+12.6 VDC -15.0 VDC
Regulation	Electronic
Protection	Input—Fused Output—Electronic Short Circuit Protected

OPTIONS: Custom Specifications
B/PAL Version
230V, 50Hz Power Supply
12, 24, or 48VDC Power Supply

AUDIO MODULES

Output Level	+45 dBmV (Adjustable)
Frequency Range	14-300 MHz
Audio Frequency Response	±1 dB of 75 Microsecond Pre-emphasis curve 50 Hz to 15 kHz
Deviation	±75 kHz Max.
Harmonic Distortion	Less than 1% (50 Hz to 15 kHz)
Hum and Noise	60 dB below 100% Modulation
Input Level	-10 dBm
Input Impedance	5000 Ohms unbalanced or 600 Ohms balanced
Spurious Signals	60 dB below max. output
Frequency Stability	±0.005%
Power Requirements	+12.6 VDC 220 mA max. (Powered by PS2500 Power Supply)

Frequency Range	4 MHz to 300 MHz (Specify)
Sensitivity	3 Microvolts for 30 dB Quieting (IHF)
Selectivity	Less than 150 kHz at 30 dB down Less than 250 kHz at 60 dB down
Passband	200 kHz
AM Rejection	50 dB
Capture Ratio	2.5 dB
Spurious Response	-80 dB Minimum
Audio Output	+10 dBm at 600 Ohms
Audio Frequency Response	±1 dB of 75 Microsecond De-emphasis Curve, 50 Hz to 15 kHz
Harmonic Distortion	Less than 1% (50 Hz to 15 kHz)
Hum and Noise	-60 dB Minimum
Power Requirements	12.6 VDC, 115 mA (Powered by PS2500 Power Supply)

OPTIONS: 50 Microsecond Pre and De-emphasis
Flat Response
Stereo Capability

AM MODULATOR SPECIFICATIONS

TELEVISION MODULATOR SPECIFICATIONS

SPECIFICATION	VISUAL	AURAL
Frequency Range:	All Channels With Modular Converter	All Channels With Modular Converter
Input Level:	Min. 0.5 Volt Peak To Peak for 87.5% Modulation	Min. -10 dBm for 100% Modulation (±25 kHz Deviation)
Input Impedance:	75 Ohms, Unbalanced, Terminating	5,000 Ohms, Unbalanced and 600 Ohms Balanced
Output Impedance:	75 Ohms	75 Ohms
Output Level Capability:	+60 dBmV	Adjustable from 12 to 27 dB Below Visual Carrier
Recommended Output:	+54 dBmV (Factory Set)	+39 dBmV (Factory Set)
Output Control Range:	20 dB, Continuously Variable	15 dB, Continuously Variable
Frequency Response:	30 Hz to 4.2 MHz at ±1dB	Within ±1 dB of Pre-emphasis Curve, 50 to 15 kHz
Frequency Stability:	0.005%	±1 kHz
Hum and Noise:	60 dB Down at 87% Modulation	60 dB Down with ±25 kHz Deviation
Distortion:		≤1% at Full Deviation
Modulation Range:	0 to 92% APL; Variable	±25 kHz

Spurious Beats:	Minimum 60 dB Below Video Carrier @ +54 dBmV (Aural Carrier @ +39 dBmV)
Color Response:	±0.5 dB Max. Diff. Gain ±1.0 Degree Max. Diff. Phase
Power Input:	105 to 125 VAC, 60 Hz, 25 Watts
Dimensions:	3½" x 12" x 19" Rack Mounted
Shipping Weight:	28 Pounds
Connectors:	Video and RF: F, Audio: Switchcraft 4 Pin
Optional Extras:	Non-standard Connectors Group Delay Network – Meets FCC Specifications 73.687 with GDF2300 Group Delay Pre-distortion Network.

HEADEND COMBINER SPECIFICATIONS

FREQUENCY RANGE	5-300 MHz
ISOLATION (min.) In-to-out In-to-in	 15.3 dB 40 dB
IMPEDANCE	75 ohm
MATCH	20 dB
TEMP. OPERATING	0^{o}C to + 50^{o}C
DIMENSIONS	19" L x 1-3/4" W x 1-1/2"H
WEIGHT	1 lb. 13 oz.

DIPLEX FILTER SPECIFICATIONS

Passband	5-116 MHz and 168-300 MHz
Maximum Insertion Loss	0.6 dB
Stopband	116-168 MHz
Stopband Attenuation	25 dB min.
Isolation, Between Highpass and Lowpass ports	40 dB min.
Terminal Match, return loss, 75 Ω impedance (minimum)	20 dB

HEADEND SPLITTER SPECIFICATIONS

Signal Splitters	Two-Way		Four-Way
Bandwidth	5-300 MHz		5-806 MHz
Splitting Loss, max.	3.7 dB		7.0 dB VHF 8.4 dB UHF
Isolation between Outputs, Min.	26 dB		30 dB

HEADEND DIRECTIONAL COUPLER SPECIFICATIONS

Model	DC-1	DC-12	DC-16
Passband (MHz)	5-300	5-806	5-806
Insertion Loss (dB)	1.1	VHF: 0.7 UHF: 0.9	VHF: 0.6 UHF: 0.8
Tap Loss (dB)	8.5	VHF:12.5 UHF:12.0	VHF:16.5 UHF:15.5
Isolation (dB)	20	VHF:30 UHF:24	VHF:35 UHF:26
Match (all terminals dB)	22	VHF:20 UHF:18	VHF:20 UHF:18
Radiation (dB)	-80	- 80	- 80

5.0 IMPLEMENTATION PLAN FOR CONSTRUCTION OF THE INTERCONNECT SYSTEM

5.1 Introduction

The development and implementation of the City's Public Telecommunications Services Project is a major undertaking. A great number of important decisions must be made, resources allocated, and actions taken during the implementation phase. This section summarizes the preliminary project implementation plans for the construction of the interconnect system.

The project team believes that the centralization of responsibility for Planning, Designing, and Construction Supervision of this project, especially as multiple contracts for construction and material supply may be required, is necessary to assure that the City will be capable of delivering its telecommunication services, meeting all requirements for performance and reliability, within the time and financial limitations established. For this reason, we feel a knowledgable systems engineer should be assigned to this project by the City. The professional, independent objectivity available in this approach will further serve to clearly distinguish the best attributes of all vendors and contractors for application in the City's Coaxial Cable Communications Interconnect System. The systems engineer should be assigned the responsibility and authority to manage this project in a manner that will result in meeting the project objectives.

5.2 System Procurement Procedures

The first step in the interconnect implementation phase is to identify the parties whose actions, responsibilities, and resources are required to successfully complete the project. As envisioned, the following parties will be involved in the implementation of the interconnect system:

(1) CITY OF COLUMBUS, DEPARTMENT OF ENERGY AND TELECOMMUNICATION -- Responsible for all aspects of interconnect funding, contracting, management and operation.

(2) CITY OF COLUMBUS, DIVISION OF TRAFFIC ENGINEERING -- Responsible for installing the Coaxial Cable Network used by the Telecommunications Center. If the traffic control system project is not implemented, the Department of Energy and Telecommunication will be responsible for installation.

(3) SYSTEMS ENGINEER -- Responsible for implementation planning, detailed system designing, aiding the Division of Traffic Engineering in its installation of the cable network, final system testing, and overall management of the project.

(4) WARNER QUBE, KBLE, ALL AMERICAN AND COAX CABLE: OWNERS OF CABLE TV FRANCHISES IN THE COLUMBUS AREA -- Responsible for providing and maintaining communications cable space (three channels downstream for distribution of the City's programming to their viewing subscribers plus one channel upstream).

(5) EQUIPMENT AND CABLE MANUFACTURERS -- Provide all necessary equipment and cable to implement the communications interconnect system.

(6) CONTRACTORS -- Responsible for all physical installations required for the coaxial cable interconnect network. The general contractor will deal directly with the Division of Traffic Engineering.

(7) UTILITY COMPANIES -- Responsible for physical pole line rearrangement to provide installation space for the interconnect plant.

During the first step of the procurement procedures, the City's systems engineer will work hand-in-hand with the Department of Energy and Telecommunication to prepare a detailed Request for Proposal (RFP). The City's system engineer will be responsible for the technical and mechanical requirements of the interconnect and how it will interface with the traffic control system. Additional RFP's will be prepared by the systems engineer to cover hardware and labor tasks not directly related to the traffic control system. The RFP responses will be evaluated and an appropriate selection will be made. The contract for the final hardware and labor tasks would then be negotiated.

Provisions will be made in all RFP's to insure that any task the City wishes to do with its own forces could be withdrawn from the major contract and implemented solely by the City.

5.3 Interconnect Implementation Plan

This section describes the preliminary interconnect plan. The preliminary plan is presented here as the first effort to

schedule, coordinate, and control the development and construction of the interconnect system.

Brief descriptions of each task or activity of the interconnect plan have been prepared. These descriptions and the associated timing estimates, responsibilities, and assumptions are the basis of the Master Schedule shown in Figures 5.1 and 5.2

Task descriptions are given below:

(1) Prepare Final Implementation Plan (Time required: 4 weeks; Responsibility: Systems Engineer) -- This task involves completing the final plan for the management and control of the interconnect project. The final schedule would be expanded and improved to include the latest factors which impact the interconnect project system. Financial plans and budgets would be worked out and milestones identified.

(2) Prepare System Strand Maps (Time required: 4 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves completing the final system strand maps outlining the final pole routings, footages and feed points for the project. The systems engineer will work closely with the traffic department to insure all the spearate interconnect points are provided on the City's final traffic control strand maps.

(3) Acceptance of System Maps (Time required: 2 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves field checking the final strand maps for accuracy, completeness,

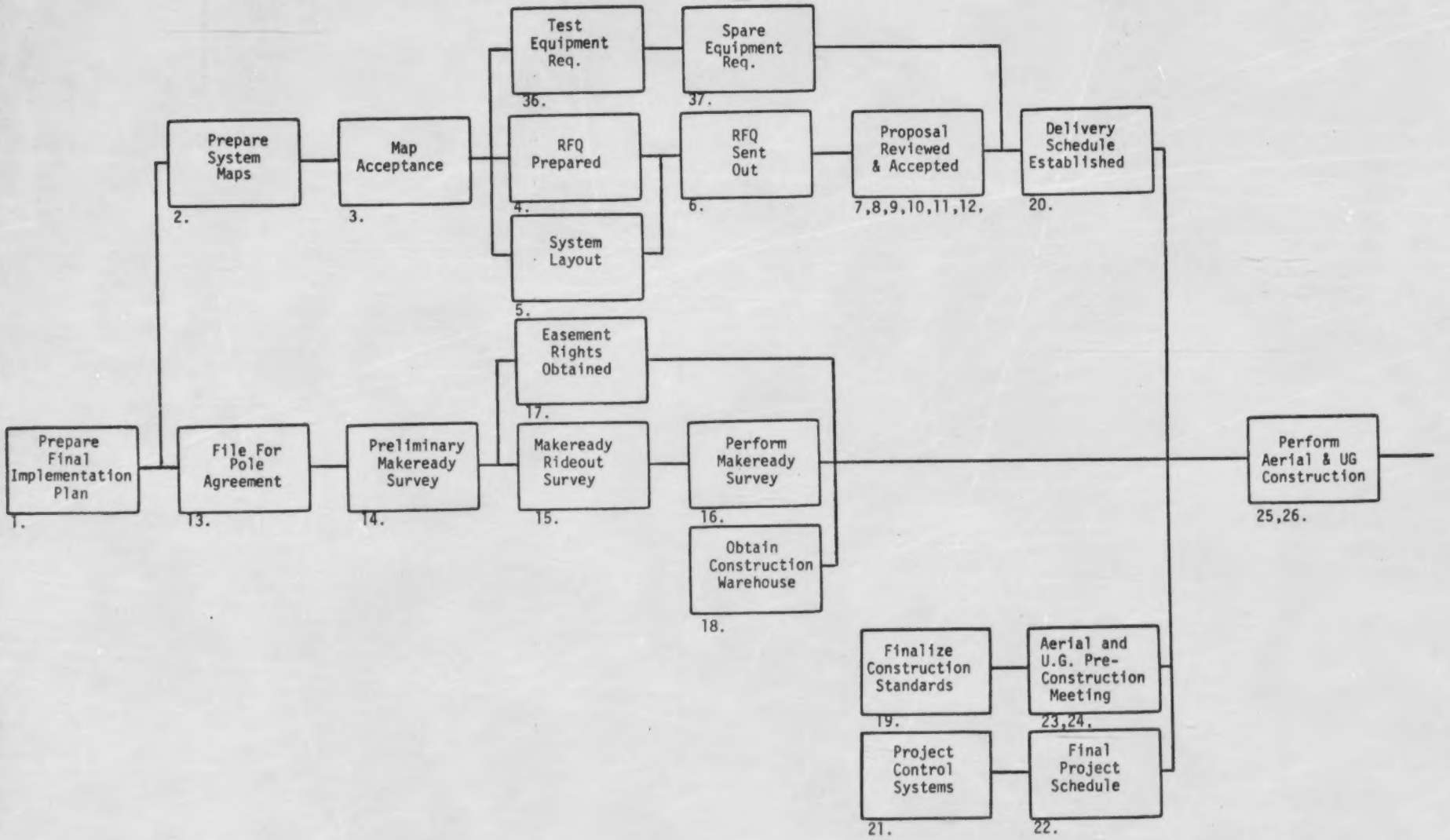


FIGURE 5.1 FLOW OF INTERCONNECT TASKS

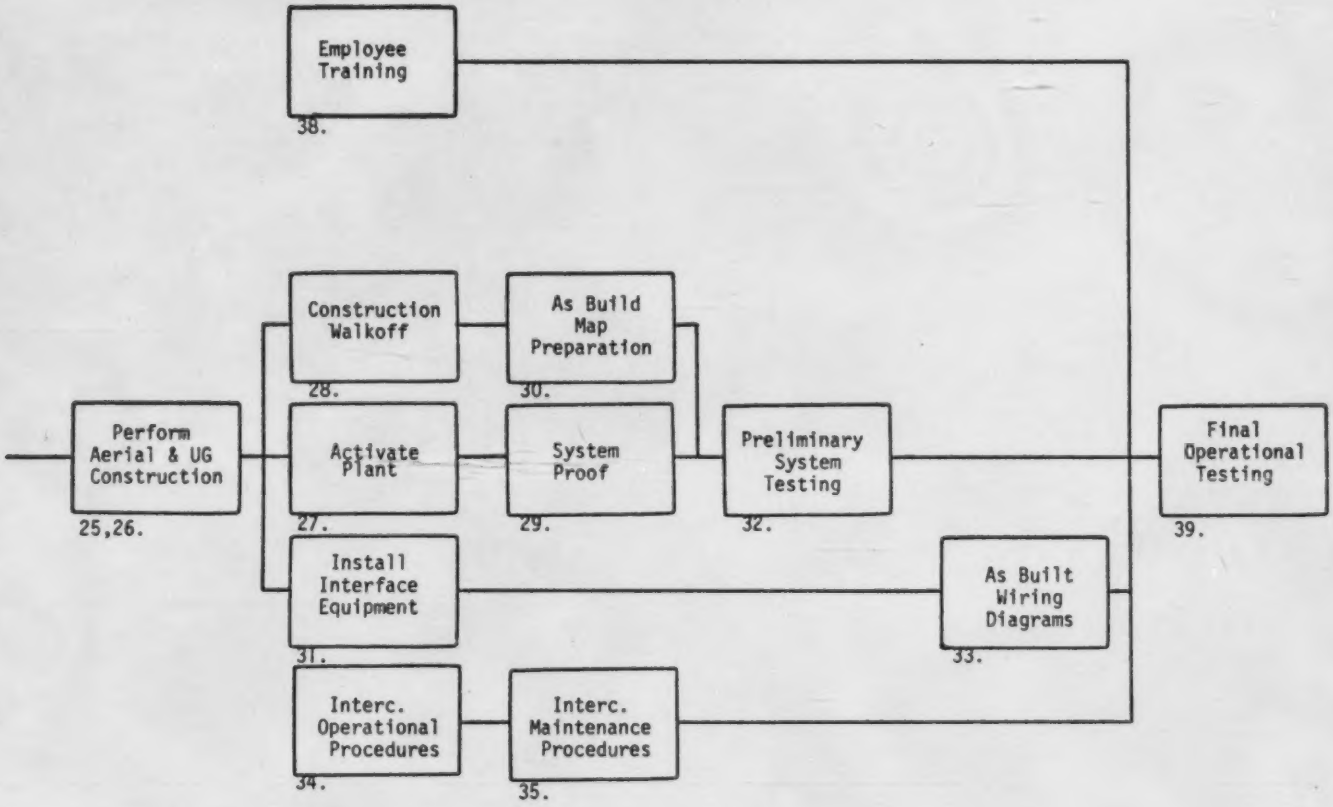
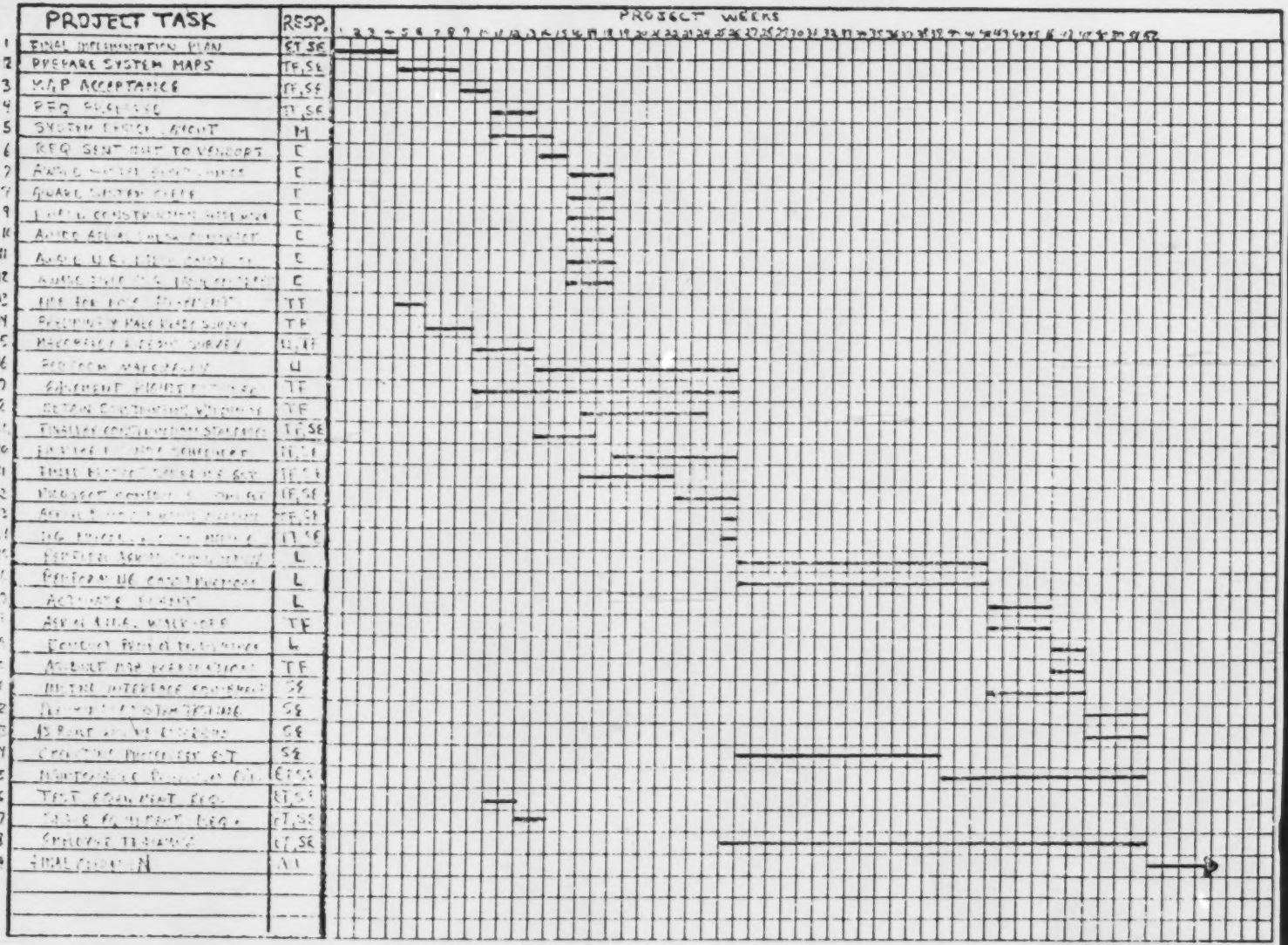


FIGURE 5.1 FLOW OF INTERCONNECT TASKS (Continued)


PROJECT TASK
RESP.
PROJECT WEEKS
1 FINAL IMPLEMENTATION PLAN ST SE
2 PREPARE SYSTEM MAPS TF, SE
3 MAP ACCEPTANCE TF, SE
4 REQ SUBMITTAL TF, SE
5 SYSTEM DESIGN AMENDMENT M
6 REQ SENT OUT TO VENDORS C
7 AWARD SYSTEM EQUIPMENT C
8 AWARD CONTRACTS F
9 FINAL CONSTRUCTION DRAWINGS C
10 ORDER ADDITIONAL EQUIPMENT C
11 ORDER UTILITY CONNECTIONS C
12 ORDER STATE TELEPHONE LINES C
13 USE FOR BIDS STATEMENT TF
14 PREPARE WORK PLAN SURVEY TF
15 MATERIALS & EQUIP. SURVEY U, LT
16 PERFORM MATERIALS U
17 EQUIPMENT PURCHASING TF
18 OBTAIN CONSTRUCTION PERMITS TF
19 FINALIZE CONSTRUCTION STAGING TF, SE
20 INSTALL & TEST EQUIPMENT U, L
21 FINAL REPORT PREPARATION SE, ST
22 PROJECT CONTROL & COORD. TF, SE
23 ADD & DELETE SYSTEM FEATURES TF, SE
24 ORDER PHASE 2 & 3 MATERIALS LT, SE
25 REVISED SCHEDULE L
26 REVIEW OF CONSTRUCTION L
27 ACCEPTANCE TESTING L
28 ASSIGN FIELD WORK CREWS TF
29 CONDUCT PUBLIC INFORMATION L
30 ACQUIRE R/W INFORMATION TF
31 INTER-INTERFACE EQUIPMENT SE
32 DEVELOP SYSTEM SOFTWARE SE
33 AS BUILT DRAWINGS SE
34 CONSTRUCT PHASE 1 ET SE
35 MAINTENANCE PLANNING ET, SE
36 TEST EQUIPMENT REQ. ET, SE
37 SPARE EQUIPMENT REQ. ET, SE
38 CONDUCT TRAINING ET, SE
39 FINAL COMPLETION All

RESPONSIBILITY CODE

C = CITY
TF = TRAFFIC ENGRG.
SE = SYSTEMS ENGINEER
ET = ENERGY & TELECOMM.
CATV = CABLE COMPANIES
M = EQUIPMENT MANUF.
U = UTILITIES
L = LABOR CONTRACTORS

FIGURE 5.2. MASTER INTERCONNECT TASK SCHEDULE

identification of "hard-build" areas, and pole crossing problems.

(4) Prepare Hardware Request for Quotations (RFQ) (Time required: 3 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves developing the final specifications for the interconnect plant and outlining them in the final bidding documents. The systems engineer will be responsible for the technical and construction specifications for all tasks directly related to the interconnect plant.

(5) Prepare System Layout (Time required: 4 weeks; Responsibility: Equipment Manufacturer) -- This task involves the design and layout of the outside plant electronic and cable equipment. Detailed design will be established on the system strand maps, outlining the routing and placement of all such equipment. The Division of Traffic Engineering and systems engineer will review the final design for accuracy and compliance to the overall system specifications.

(6) Hardware Bidding (Time required: 2 weeks; Responsibility: City) -- Based on the final detailed design specifications, Requests for Quotations for the various system components and tasks will be channeled through the City for bidding.

(7) Award System Electronics Contract (Time required: 3 weeks; Responsibility: City)

(8) Award System Cable Contract (Time required: 3 weeks; Responsibility: City)

(9) Award System Construction Hardware Contract (Time required: 3 weeks; Responsibility: City)

(10) Award Aerial System Construction Labor Contract (Time required: 3 weeks; Responsibility: City)

(11) Award Underground System Construction Labor Contract (Time required: 3 weeks; Responsibility: City)

(12) Award Field Engineering Labor Contract (Time required: 3 weeks; Responsibility: City)

(13) File for Pole Attachment Agreements (Time required: 2 weeks; Responsibility: Traffic Engineering) -- This task involves the filing for and issuance of Pole Attachment Agreements from the telephone, power and Municipal City's utilities to allow the placement of the interconnect plant on their pole facilities.

(14) Preliminary Makeready Survey (Time required: 3 weeks; Responsiblity: Traffic Engineering) -- This task involves the physical rideout of the pole facilities which the interconnect system will be attached to. This survey will determine the physical clearances and pole numbers on each of the poles to which the interconnect will be attached. Pole permit applications will be prepared and submitted to the appropriate utilities.

(15) Makeready Rideout Survey (Time required: 4 weeks; Responsibility: Utility Companies and Traffic Engineering) -- This task involves the physical rideout of the pole facilities with the Utility Companies to determine the cost of rearrangement on all pole locations which do not provide adequate clearance for the interconnect plant. The Utility Companies will then prepare their estimated costs for rearrangement (makeready) and submit them to the City for approval and payment.

(16) Perform Pole-Line Makeready (Time required: 13 weeks; Responsibility: Utility Companies) -- This task involves physically rearranging the power and telephone facilities to provide the necessary clearances for the interconnect system. This work performed by the Utility Companies.

(17) Plant Easement Rights (Time required: 17 weeks; Responsibility: Traffic Engineering) -- This task involves obtaining special easement rights for any underground, railroad or freeway crossings. These types of crossings usually require special easement or crossing agreements between the City and entity involved. Tree trimming and the setting of the new poles where required should also be completed at this time to insure that the pole-line plant is ready for construction.

(18) Obtain Construction Warehouse (Time required: 8 weeks; Responsibility: Traffic Engineering) -- This task involves locating and leasing an appropriate warehouse facility to store the electronic and construction

materials necessary to construct the plant. The warehouse should be centrally located to the areas to be built, thus avoiding costly travel time during the construction phase.

(19) Finalize Construction Standards (Time required: 4 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves finalizing a detailed description of the construction parameters to be used during the construction of the system. Special attention should be given to bonding and grounding techniques and cable splicing.

(20) Finalize Delivery Schedules (Time required: 8 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves the scheduling of materials to the job site in an orderly fashion. Special attention must be given to long lead times to insure timely delivery to the project. The Division of Engineering and Systems Engineer will keep abreast of material delivery schedules to insure that the overall project completion schedule is not affected.

(21) Organize Project Control Systems (Time required: 6 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves the preparation and implementation of on-site control systems. This includes but is not limited to: inventory control, project purchases, construction coordination, efficiency planning, etc.

(22) Create Firm Project Schedules (Time required: 4 weeks; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves preparing a detailed installation plan. All facets affecting the project will be considered and a detailed schedule will be established.

(23) Aerial Plant Pre-Construction Meeting (Time required: 1 week; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves the meeting of all parties involved in aerial plant construction. All construction parameters, contractor duties and responsibilities, reporting procedures, billing and inventory management will be discussed to insure all parties have a clear understanding of what will be required. Project objectives and installation procedures will be reviewed and goals set to maintain the project schedules.

(24) Underground Pre-Construction Meeting (Time required: 1 week; Responsibility: Traffic Engineering and Systems Engineer) -- This task involves the same tasks as outlined in Task 23.

(25) Perform Aerial Construction (Time required: 16 weeks; Responsibility: Aerial Contractor) -- This task involves installing the strand on the poles, lashing the cable to the strand, splicing in the electronic components, installing the power supplies, installing anchors, bonds and ground rods. The above-listed tasks will be done in accordance with the detailed construction practices provided the contractor.

(26) Perform Underground Construction (Time required: 16 weeks; Responsibility: Underground Contractor) -- This task involves trenching and plowing, boring under streets, placement of cable in trench or conduit, splicing in the electronics components, installing the power supplies, installing pedestals, and restoration. The above-listed tasks will be done in accordance with the detailed construction practices provided the contractor.

(27) Activate Plant (Time required: 4 weeks; Responsibility: Engineering Labor Contractor) -- This task involves the activation of the system power supplies, the installation of appropriate power blocks, amplifier level adjustments will be done by using standard CATV sweep methods.

(28) Aerial and Underground Construction Walkoff (Time required: 4 weeks; Responsibility: Traffic Engineering) -- This task involves physically riding out all constructed plant to insure compliance with the system design prints and construction specifications. All contractors involved in the construction phase (aerial and underground) will be requested to provide a representative to participate in the final system walkoff. All final billing and final clean up tasks will be established with the information taken during the walkoff.

(29) Conduct Proof of Performance (Time required: 2 weeks; Responsibility: Engineering Labor Contractor) -- This task involves the testing of the outside coaxial cable network to insure compliance with the system design specifications. All tasks outlined

in the Recommended Proof of Performance Procedures will be used to test the system.

(30) As-Built Map Preparation (Time required: 2 weeks; Responsibility: Traffic Engineering) -- This task involves the preparation of a final set of system design prints outlining the exact location of the system as-built by the contractor. This information will be obtained during the construction walkoff.

(31) Install Interconnect Interface Equipment (Time required: 6 weeks; Responsibility: Systems Engineer) -- This task involves the installation of interface equipment at the QUBE, KBLE, Coaxial and All American headends. Interface equipment will also be installed in the main telecommunications center.

(32) Preliminary System Testing (Time required: 4 weeks; Responsibility: Systems Engineer) -- This task involves the full testing of the interconnect plant to insure picture quality at all CATV company headends. Remote points along the traffic control plant will also be chosen to insure picture quality at the telecommunications center.

(33) As-Built Wiring Diagrams (Time required: 4 weeks; Responsibility: Systems Engineer) -- This task involves documenting the final interface equipment layout in a final wiring diagram format. All equipment, cables, etc., will be fully labeled and noted on the wiring diagram to insure ease of identification at a later date.

(34) Interconnect Operating Procedures (Time required: 13 weeks; Responsibility: Systems Engineer) -- This task involves the finalization of the interconnect operating methods, defining specific responsibilities and reporting procedures. Documentation will provide the Department of Energy and Telecommunication with detailed operating procedures.

(35) Plant Maintenance Procedures (Time required: 13 weeks: Responsibility: Department of Energy and Telecommunication and Systems Engineer) -- This task involves establishing maintenance procedures for the upkeep of the interconnect system. It is currently envisioned that the Division of Traffic Control will cooperate in maintaining the outside physical plant along with their own traffic control equipment. Key areas to be addressed in the Maintenance Procedures are: Replacing electrical equipment, trouble-shooting, setting-up and carrying out a systematic preventative maintenance program, monitoring plant operations, etc.

(36) Test Equipment (Time required: 2 weeks; Responsibility: Department of Energy and Telecommunication and Systems Engineer) -- This task involves establishing and obtaining the necessary test equipment to test and maintain the interconnect system.

(37) Spare Equipment (Time required: 2 weeks; Responsibility: Department of Energy and Telecommunication and Systems Engineer) -- This task involves establishing and obtaining the necessary spare equipment to maintain the interconnect system.

(38) Employee Training (Time required: 26 weeks; Responsibility: Department of Energy and Telecommunication and Systems Engineer) -- At various phases throughout the project, training will be provided to City personnel. As envisioned, both maintenance and operation training will be available and this task involves seeing that the proper training is carried out.

(39) Final Operation (Responsibility: All Parties) -- This task involves bringing the interconnect system completely on-line in an operational mode. During this time, Department of Energy and Telecommunication personnel will be responsible for the operation of the system but, if problems are encountered, the systems engineer and various other contractors will be called in as needed to assist in resolution of the problems.

5.4 System Operations and Maintenance Concept

During the implementation phase, detailed operational procedures will be developed and training carried out. It is envisioned that the organizational structure of the Government Telecommunications Center will be divided into three basic areas of responsibility (See Figure 5.3):

1. Policy
2. Operations and Equipment Maintenance
3. Plant Maintenance

The first area of responsibility will be Telecommunications Center Policy. The Department of Energy and Telecommunication will establish operational policy for the facility and will recommend any regulations, if needed, to be enacted by City Council. The Cable Television Advisory Commission will advise the City on issues related to the facility.

The second area of responsibility will be the Telecommunications Center Operations. This area primarily concerns itself with the day-to-day operations of the facility. The Department of Energy and Telecommunication will operate the facility. A Cable Center Broadcast Director will be responsible for the daily operations and maintenance of the Government Telecommunications Center. Additional key support personnel will be the Cable Braodcast Producer/Director and the Cable Center Chief Technician.

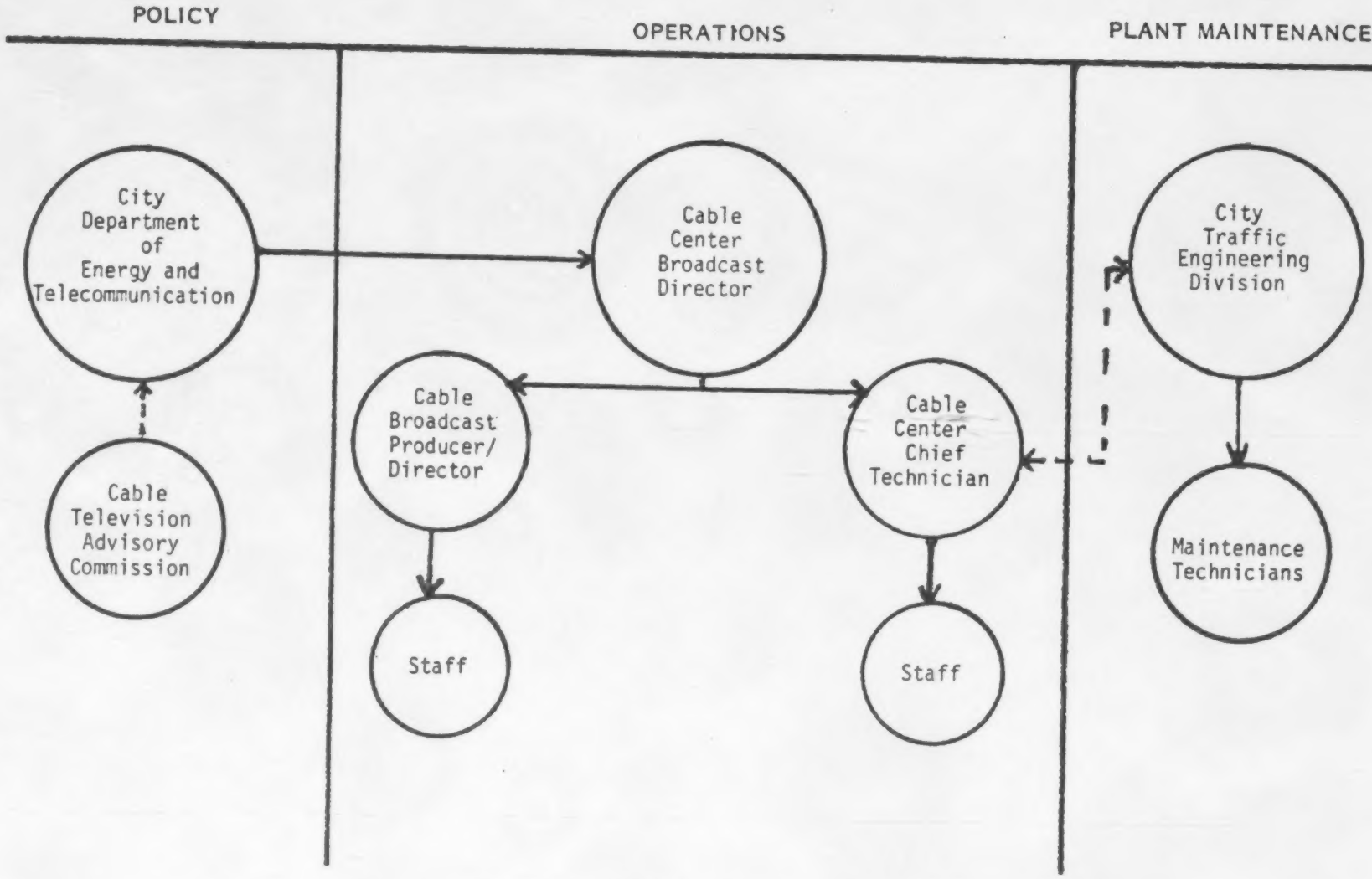


FIGURE 5.3. TELECOMMUNICATIONS CENTER ORGANIZATION CHART.

BATTELLE — COLUMBUS

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The third and final area of responsibility will be for the Telecommunications Center Outside Plant Maintenance. The City's Department of Energy and Telecommunication will be responsible for the daily maintenance of the outside cable network. It is recommended that one field maintenance technician be dedicated to the operational upkeep and maintenance of the Telecommunications Center Cable Network.

5.5 Interconnect Cost Projections

Table 5.1 summarizes the estimated costs to build and operate the Interconnect Cable Network. The projected costs are broken down into the following major elements:

Outside Interconnect Cable Network Costs	(Table 5.2)
Telecommunications Center Interface Equipment Costs	(Table 5.3)
Telecommunications Center Master Control Equipment Costs	(Table 5.4)
Interconnect Interface Equipment Costs at Each Headend	(Table 5.5)
Remote Site Interface Equipment Costs	(Table 5.6)
Interconnect Spare Equipment Costs	(Table 5.7)

TABLE 5.1. INTERCONNECT COST PROJECTION

Cost Element	
Outside Interconnect Network Costs	$185,750
Inside Interface Equipment Costs	$ 30,500
Master Control Equipment Costs	$138,000
Equipment Costs at CATV Headends	$ 79,200
Remote Site Interface Equipment Costs	$ 24,000
Spare Equipment Costs	$ 54,000
TOTAL COSTS:	$511,450

TABLE 5.2. OUTSIDE INTERCONNECT CABLE NETWORK COSTS

COST PARAMETERS	Estimated COST P/MILE	15-MILE PLANT (Shared With Traffic System	5-MILE PLANT (Not Shared W/ Traffic System
1. Strand Mapping	$ 200	$ 3,000(t)	$ 1,000(i)
2. Makeready Survey	$ 200	$ 3,000(t)	$ 1,000(i)
3. Pole Line Makeready Costs	$1,000	$15,000(t)	$ 5,000(i)
4. System Electronics	$4,000	$60,000(i)	$20,000(i)
5. System Cable	$3,700	$55,500(i)	$18,500(i)
6. Construction Hardware	$1,300	$19,500(t)	$ 6,500(i)
7. Construction Labor	$3,400	$51,000(t)	$17,000(i)
8. Miscellaneous Costs	$ 250	$ 3,750(t)	$ 1,250(i)

Cost Responsibility: (t) = Traffic Control
(i) = Interconnect

TOTAL INTERCONNECT COSTS = $185,750

Cost Assumptions:

1. The Traffic Control System will be available for use in the Interconnect.
2. The Telecommunications Center and Traffic Control Surveillance System facilities will be in close proximity to each other.
3. All underground duct space downtown for cable runs will be provided without cost.
4. A clear right-of-way can be obtained for the new interconnect routes.

TABLE 5.3. TELECOMMUNICATIONS CENTER INTERFACE EQUIPMENT COSTS

Quantity	Description	Estimated Cost
3	FM Audio/Video Modulators	$ 6,000
6	FM Audio/Video Demodulators	$15,000
1	AM Modulator	$ 2,000
4	Diplex Filters	$ 1,500
1	2x8 Manual RF Switch	$ 1,000
Assorted	Combining Hardware, Cable & Rack	$ 3,000
1	Standby Power Supply	$ 2,000
	TOTAL COST:	$30,500

TABLE 5.4. TELECOMMUNICATIONS CENTER MASTER CONTROL EQUIPMENT COSTS

Quantity	Description	Estimated Cost
1	20x20 Routing Switcher	$10,000
1	Patch Panel & Cords	$ 2,000
4	TBC Frame Synchronizer	$72,000
1	Three-Channel Character Generator	$25,000
20	Video Monitors (B&W)	$ 6,000
1 pkg.	Audio/Video Test Equipment	$12,000
3	FM Tuners	$ 1,000
Assorted	Racks, Hardware & Cable	$10,000
	TOTAL COST:	$138,000

TABLE 5.5. INTERCONNECT INTERFACE EQUIPMENT COSTS AT EACH HEADEND

Quantity	Description	Estimated Cost
1	FM Audio/Video Modulator	$ 2,000
3	FM Audio/Video Demodulator	$ 7,500
3	AM Modulator	$ 6,000
1	Diplex Filter	$ 300
1	Standby Supply	$ 2,000
Assorted	Hardware, Cable & Rack	$ 2,000
	COST Per Headend	$19,800
	(x 4 Headends)	
	TOTAL COST:	$79,200

TABLE 5.6. REMOTE SITE INTERFACE EQUIPMENT COSTS

Quantity	Description	Estimated Cost
1	FM Video Modulator	$ 2,000
1	Diplex Filter	$ 300
Assorted	Hardware	$ 2,000
1	TV Monitor	$ 500
	COST Per Remote Site	$ 4,800
	(x 5 Remote Packages)	
	TOTAL COST:	$24,000

TABLE 5.7. INTERCONNECT SPARE EQUIPMENT COSTS

Quantity	Description	Estimated Cost
1	Outside Plant Equipment Spares	$10,000
2	FM Audio/Video Modulator	$ 4,000
2	FM Audio/Video Demodulator	$ 5,000
1	AM Modulator plus Tunable Output	$ 3,000
5	Diplex Filter	$ 1,500
Assorted	Splitters, Couplers & Cable	$ 500
1 pkg.	RF Test Equipment	$25,000
Misc.	Spare Parts & Equipment	$ 5,000
	TOTAL COST:	$54,000

6.0 FACILITIES PLAN

6.1 Introduction

This section develops the production requirements for the applications described above. Each application is characterized in terms of the nature of the production required, the source of the event, its channel utilization, its equipment and manpower requirements, and the schedule for its implementation. This information is detailed in Table 6.1 and described in Section 6.2 below. From this detailed information, a summary of the manpower, and equipment requirements are described in Section 6.3.

6.2 Description of Production Requirements for Each Application

The general characteristics of the application set which influence the level of production facilities required for the GTC are listed in Table 6.1 For each application, this table categorizes the type of program involved, the program source, program production characteristics, a projected implementation schedule, and an estimated monthly manpower cost. Each of these information fields are explained briefly below:

6.2.1 Program Type

The type of program defines a broad class of production requirements ranging over a broad spectrum of technical complexity, manpower and equipment requirements. These programs range from video productions, textual information programs, text on demand, and various digital sensing or communications programs on the interconnect as well as the CATV company's cable distribution. The simplex text programs require the least to produce.

TABLE 6.1 NON-COMMERCIAL APPLICATIONS FOR ACCESS CHANNELS

	Program Type						Production Source			Interconnect Utilization Characteristics					Production Characteristics			Implementation Schedule				Manpower Requirements				Notes
	Live Video Program	Taped Video Program	Simple Text Program	Text on Demand Program	Digital Communications on Interconnect	Digital Communications on CATV Systems	Remotely Produced	Studio Produced	Production Provided by Source	Typical Program Duration	Frequency Per Month	Repetitions Per Month	Channel Utilization/Mo	Cable Network	Production Class	Production Team Size (Persons)	Production Ratio	Hours/Month of Original Programs (per year)				Hours/Month (per year)				
										(Hrs)			(Hrs)					2	3	4	5	2	3	4	5	
A. Governmental Use																										
1. Local government meetings, school board meetings, planning and zoning board meetings, video trials - live	X						X	X		2	10	1	40	IOC	3C	7	3	4	8	16	20	84	168	336	420	
2. Local government reports, community relations programming, special briefings for public - taped		X						X		1	5	4	20	OC	3C	7	2	1	2	5	5	14	28	70	70	
3. Meeting schedules, announcements, etc., - text			X					X	X	.17	84	4	56	OC	CG	1	3	7	14			21	42	42	42	1
4. Personnel training for local government (police, fire, finance, etc.), jail programs (instructional, recreational)		X							X	1	5	4	20	I	TP	0	0					0	0	0	0	2
5. Government/legal service information (procedures for voter registration, filing small claims, consumer fraud, special licensing, tax payments, assessments, etc.)- videotext				X					X	.25	5	1000	0	OC	VT	1	3	0	0	.5	1.25	0	0	1.5	3.75	3
6. Emergency communications to the public (major problems) - live	X						X	X		.5	.17	1	.16	IOC	1C	4	2	0	0	.08	.08	0	0	.64	.64	
7. Intragovernmental conferences, meetings (video conferencing)	X				X		X		X	2	8	1	35	I	TC	0	-	Beyond 5 years				0	0	0	0	
8. Interoffice mail (electronic mail, facsimile)					X		X		X	.03	800	1	4	I	EM	0	-	Beyond 5 years				0	0	0	0	
9. Court, police uses (preliminary arraignment, depositions, bail interviews, line-ups, filing of motions) - live	X				X		X		X	1	100	1	216	I	TC	0	-	Beyond 5 years				0	0	0	0	
10. Town meetings - live, interactive	X					X	X	X		2	1	1	2.1	IOC	LI	7	3	Beyond 5 years				0	0	0	0	
11. Public transit schedules, tax information - videotext				X					X	.25	20	100	0	OC	VT	1	3	0	0	2	5	0	0	6	15	3
12. Traffic conditions, storm warnings - text, frequent update			X					X	X	.08	84	16	108	OC	CG	1	3	6.7	6.7	8.7	6.7	28	20	20	20	1
13. Police car location	X				X				X	24	28	1	168	I	CL	0		Beyond 5 years				0	0	0	0	4
14. Traffic signal control	X				X				X	24	28	1	0	I	CL	0	0	672				0	0	0	0	5
15. Traffic monitoring (TV) and control	X				X				X	24	28	1	0	I	CL	0	0	672				0	0	0	0	5
16. Public building resource monitoring	X				X				X	24	28	1	112	I	CL	0	0	Beyond 5 years				0	0	0	0	4
17. Public building resource management	X				X				X	24	28	1	0	I	CL	0	0	Beyond 5 years				0	0	0	0	4
18. Gas, water, electric meter reading	X					X 2-way			X	.05 sec.	300,000	1	.7	OC	CL	0	0	Beyond 5 years				0	0	0	0	6
19. Water station monitoring and control	X				X				X	24	28	1	.1	I	CL	0	0	Beyond 5 years				0	0	0	0	5
20. County-wide emergency call system (discrimination of incoming signal and routing to appropriate office)	X					X 2-way			X	1 min.	40K	1	224	OC	CL	0	0	Beyond 5 years				0	0	0	0	6

TABLE 6.1 Cont. NON-COMMERCIAL APPLICATIONS FOR ACCESS CHANNELS

	PROGRAM TYPE						PRODUCTION SOURCE			INTERCONNECT UTILIZATION CHARACTERISTICS					PRODUCTION CHARACTERISTICS			IMPLEMENTATION SCHEDULE			MANPOWER REQUIREMENTS					NOTES
	Live Video Program	Taped Video Program	Simple Text Program	Text on Demand Program	Digital Communications on Interconnect	Digital Communications on CATV System	Partially Produced	Studio Produced	Production Provided by Source	Typical Program Duration	Frequency Per Mo.	Repetitions per Mo.	Channel Utilization/Mo. (Prs./60 Hz Char.)	Cable Network	Production Class	Production Team Size (Persons)	Production Ratio	Hours/Month of Original Programs (per year)			Hours/Month (per year)					
																		2	3	4	5	2	3	4	5	
B. Social Service Use																										
21. Public Service Announcements		X							X	.03	50	56	84	OC	TP	0	0					0	0	0	0	
22. Public service information programs		X							X	1	20	8	160	OC	TP	0	0					0	0	0	0	
23. Institutional originated programs (library, museum, art gallery, cost, schools, etc.)	X	X					X		X	1	4	8	64	IOC	TP	0	0					0	0	0	0	
24. Library information - data on request				X			X		X	.5	100	10	0	IOC	CL	0	0					0	0	0	0	3
25. Instructional programs (elementary, secondary, post-secondary, adult) to homes		X							X	1	20	12	240	OC	TP	0	0					0	0	0	0	
26. Instructional programs to schools, other institutions		X					X		X	1	20	4	160	I	TP	0	0					0	0	0	0	
27. Credit courses (for fee) to homes		X							X	1	20	12	240	OC	TP	0	0					0	0	0	0	
28. Informational/recreational programs for special groups (elderly, bed-ridden, handicapped, shut-ins)		X							X	1	8	12	96	OC	TP	0	0					0	0	0	0	
29. Instructional programs with interactive component	X					X	X		X	1	20	1	47	IOC	LI	1	1.5		Beyond 5 Yrs.			0	0	0	0	
30. Community calendar - text (same as 3)			X					X	X	.17	28	12	57	OC	CG	1	3	4.8	4.8	4.8	4.8	14.4	14.4	14.4	14.4	1
C. Public Access Use																										
31. Community produced films/videotapes		X							X	1	20	8	160	OC	TP	0	0					0	0	0	0	
32. Live educational/cultural/recreational events	X	X					X		X	1	8	3	48	IOC	TP	0	0					0	0	0	0	
33. Political candidates/ballot issues (county-wide)	X	X					X		X	1	20	12	400	IOC	TP	0	0					0	0	0	0	
34. Individual Appearances	X						X		X	.5	5	1	5	OC	TP	0	0					0	0	0	0	

Video interactive programs involving response from homes on the four CATV systems are the most challenging to produce, requiring the solution of many technical issues. Because of the complexity and high costs of this kind of program, this class of applications will be the last to be implemented on the interconnet.

6.2.2 Production Source

The production source category defines whether the production will be provided by an organization outside the aegis of the Government Telecommunications Center (GTC), whether it will be produced in the GTC studios, or whether is would be producted by the GTC staff on location at some remote site. The level of production effort varies with these circumstances.

6.2.3 Interconnect Utilization Characteristics

The program production characteristics list the expected hours of original production required and the channel utilization. The channel utilization value is computed from the product of the program duration, the frequency of program production/month, and the number of repetitions/month. The channel requirements are doubled if two-way video channels are required. If digital channels are required, the additional allotted bandwidth is estimated based on the expected data rates on the channel. The column labeled cable network relates the elements of the overall cable network which will be involved in the production and/or transmission of the program. The symbols used in this column are defined as follows:

I Institutional Loop. This is the Traffic Control Cable. It is selected to served the function of the institutional loop because of its wider distribution throughout the county. Technically, the institutional loop may also involved locations interfaced through the overlashed cable, however for simplicity we will refer to the Traffic Engineering Division cable as the Institutional Loop.

O Overlashed Cable. The overlashed cable network will be construction at the same time as the Traffic Control Cable network and overlashed to it. The overlashed cable will be constructed under the auspices of the Department of Energy and Telecommunication. Because of its greater available bandwidth, the overlashed cable will provide the primary interconnect between the Telecommunications Center and the four CATV

C CATV Cable. This symbol refers to the cable plant owned and operated by the four commercial cable operators in Columbus.

6.2.4 Production Characteristics

The production class column in the table provides a general categorization of the production resources required for each application. The production classes are as follows:

Class ID	Description
3C	Three camera productions with operational editing for taped programs. Manpower Requirements: 1 Director 3 Cameramen 1 Audio/Video Technician 1 Character Generator Operator 1 Assistant Director/Floor Manager 7

Equipment Requirements:

3 Cameras - Color
7 Microphones
1 Character Generator
1 Audio Mixer
4 Monitors B/W
2 Color Monitors
1 Video Tape Deck
7 Headsets and Production Control Audio System
1 FM Modulator
1 Editing System
Miscellaneous Cable, Fittings, Hardware, Tools

1C One Camera Production

Manpower Requirements:

1 Director
1 Cameraman
1 Audio/Video Technician
1 Character Generator Operator
4

Equipment Requirements:

1 Color TV Camera
2 Microphones
1 Character Generator
1 Audio Mixer
1 Color Monitor
1 B/W Monitor
1 Video Tape Deck
4 Headset and Production Audio Systems
1 FM Modulator
Miscellaneous Cables, Fittings, Hardware, Tools

TP — Video Tape Player Only

This production class provides the capability of playing video tapes producted by someone other than the Department of Energy and Telecommunication. When this production class is specified, the expectation is that the GTC will be provided a video tape which is ready to be broadcast.

Manpower Requirements:

1 Master Control Operator - to mount the tape

Equipment Requirements:

1 Videp Tape Player

CG — Character Generated Text Program

The programs in this category consist only of text.

Manpower Requirements:

1 Character Generator Operator (Possibly Master Control

Equipment Requirements:

1 Character generator

VT — Videotext System - Text on Demand

Manpower Requirements:

1 Operator to enter text into system hardware
1 Videotext Central System with frame storage editing terminal, etc.
Many Videotext Remote Reception Units

TC — Teleconference Production

Cable teleconferencing facilities must be readily available to those who desire to use them. Otherwise the facility may be used only rarely and therefore not justify the expense.
To provide a readily accessible facility, two video channels, one upstream and one return would be dedicated to the teleconference application. Teleconferencing may involve a one-to-one correspondence between geographically separated sites, or a many-to-many correspondence. To prevent one TV camera signal from interfering with the camera signal originating at some other site (possible on the same trunk), the remote camera's output will be switch on and off such that only one camera will be transmitting at a time. This switching will be directed by one of the participants of the meeting, the chairman or moderator of the meeting. The involvement of GTC staff should be avoided so that their availability is not a prerequisite for a teleconference to occur.

The meeting moderator will effect the camera switching via two-way digital communications to a computer system provided and maintained by the GTC. The moderator would communicate to the computer via a simple CRT terminal interfaced to the cable via some digital cable interface unit (CIU) which modulates and demodulates the digital control messages onto the appropriate slow-speed (< 100K baud) digital communications channel.

Each remote participant of the teleconference would be supplied with camera, microphone, AM modulator, plus a simple key pad. The switching of the cameras would be controlled by one member of the conference, its moderator or chairman. When an individual wishes to address the conference, he or she would request the floor (or more appropriately the camera) by pressing one of the buttons on the simple 12-button key pad. A computer system at the GTC would route the incoming digital requests to the moderator and identify the requestor by writing his name and station ID to the alphanumeric generator at the moderator's location.

The moderator would recognize one of the requests by depressing the appropriate button on the key pad. This commands the computer to turn off the previously transmitting camera and switches on the camera specified by the moderator. The key pads could also be used to poll the conference participants on their feelings concerning the various topics occurring during the conference.

The major cost of this approach to teleconferencing will be the computer system hardware, the computer interface to the cable and the computer system program. However, a computer system at the GTC would be required for several other applications as well, thereby spreading the fixed costs over a wider basis of applications. Prior to the implementation of the computerized applications on the interconnect, a thorough functional specification, detailed design, and development project plan must be established. Due to the ambitious production growth expected during the first four years, the development of a teleconferencing capability will begin during the fifth year.

Manpower Requirements:

None

Equipment Requirements:

At each site -
1 Camera
1 Microphone
1 Moderator
1 Monitor
1 Request Box
1 Cable Interface Unit

At GTC -
1 digital computer system (minicomputer)
1 digital transmitter/receiver interface
to the computer
System control program

At Moderator -
All the remote site hardware, plus
1 CRT terminal
1 cable interface unit

EM Electronic Mail

The electronic mail facility will be controlled by a digital computer at the GTC. The computer system will supply a store and forward message system, message priorities, message index, etc.

Manpower Requirements:

None

Equipment Requirements:

At each site -
1 CRT terminal
1 Cable Interface unit

At GTC -
1 computer system - minicomputer with disc
1 transmitter/receiver interface between cable
and computer

The computer system could be the same one used for teleconferencing. As was mentioned earlier, this facility will most likely not be operational within the first five years of GTC development.

CL — Communications Link Only

Applications falling into this category will be produced, controlled, monitored, etc., by groups outside the responsibility of the GTC. The only requirement is the provision of an appropriate communications channel(s) to carry the TV program, digital signals, etc.

Manpower Requirements:

None

Equipment Requirements:

1 Processor to remodulate the incoming channel onto the appropriate outgoing channel.

LI Live Interactive

This production category provides the capability of interactive response from the home viewers. The most effective way of interrogating varies with the CATV system. For those systems (COAX and QUBE) which already have a computer monitoring facility, it is recommended that the CATV system computers be responsible for geographic area switching and report the currently switched on area to the GTC computer over a digital communications link. Additionally, the subband return signals from that area would be passed on to the GTC over the interconnect. For the CATV systems, KBLE and ATC, not currently providing a computer polling or monitoring system, The Telecommunications Center would poll the viewers. For these systems, an active and clean subband channel capability would be a necessity, along with the necessary RF switches to switch on and off geographic areas of the trunk thereby limiting the effects of signal intrusion and providing a level of multiplexing.

Additionally, many remote miniterminals would be provided to the viewers to enable them to enter their opinions. Currently, only QUBE provides some of their customers with a unit capable of opinion polling.

Finally, substantial software development would be required for the Telecommunications Center computer, as well as modifications for, or additions to the QUBE and COAX systems. Because of the need for a computer and software development, we do not envision this application becoming operational during the first five years of operations at the GTC.

Manpower Requirements (During Production):

1 Master Control Operator

Equipment Requirements:

1 Computer System
  Computer interface to the cable
  Many Remote Terminal units
  Computer Software

The production team size summarizes the number of GTC personnel required for this production.

The production ratio is the ratio of production time to program broadcast length. For example, a production ratio of 2 means that for every program hour, the production team will spend 2 hours in preparing for and creating the program. By the real time nature of live programs, they usually carry a lower production ratio than a taped program which permit production stopages and may require editing. Remote productions require a higher production ratio due to the travel, setup and tear down time requirements.

6.2.5 Implementation Schedule

The implementation schedule stages the growth of production at the GTC for the foreseeable future. The first year of development is dedicated to the construction of the interconnect cable plant, the hiring of staff, purchase of equipment and acquisition of the facilities space. The second year sees the preparation of simple text displays, and limited live and remote TV production. A "videotext" type program permitting the viewers to request a particular frame of text will begin production in the fourth year. Some limited digital communications on the institutional loop cable will begin in the second year for the traffic monitoring and control application. The other digital communications oriented applications involve the acquisition of a computer control system, software development, remote devices, etc., by the GTC. The introduction of applications requiring two way digital communications will not occur in the first five years of the initial development effort.

6.2.6 Manpower Requirements

The production team manpower requirements are computed from the product of the hours of original program material and the production ratio. The schedule of implementation was designed to provide a fairly uniform growth in productivity over the first five years.

6.2.7 Notes

This column provides references to additional notes relevant to individual applications. The test of the notes follows:

1. The production time estimate for text on the character generator only includes the time for typing, proofing and correcting the copy on the character generators. The writing of the meeting schedules, announcements, etc., is not included.

2. The training films are assumed to be provided to the GTC by the police, fire, or other department which is responsible for their production. The GTC will provide the service of broadcasting their program on a specified schedule and will provide the communication link to institutions authorized to receive the program. If security is required over the programmed material, the department which created the program will be responsible for providing the required scrambling equipment. This program would be broadcast over a non standard video channel (e.g. not 2-13) and would be broadcast over the institutional loop cable to provide a certain degree of security even without scrambling. Any higher level of security would be the responsibility of the organization which provided the program.

3. "Text on Demand" services will be provided via the video-text type technology where the text is transmitted during the interframe period on a standard TV channel. This does not interfer with the programs already offered on the channel. Therefore, the channel utilization bandwidth requirements are zero.

   The production requirements for the text on demand applications only involve the typing of text into the character generators, proofing it and correcting it. The writing and preparation of the material to be typed into the text buffers is the responsibility of the organization which is served by the text.

4. The applications which require digital monitoring necessitates an operational computer at the GTC interfaced to the interconnect networks. As was indicated earlier in the report, applications requiring this support are not likely to be implemented within the first five years of the GTC development.

5. Digital monitoring and control will be under the control of computer systems outside the control of the GTC. The GTC merely provides the bandwidth required by the outside organizations on the institutional loop cable.

6. Digital monitoring on these applications require two way digital communications on the overlash cable and on the CATV networks. Since COAX and QUBE currently use the subband return channels on their cable systems for commercial applications, additional applications would require an integrated coordination of subband area switching and data capture. The simplest workable approach to provide this integration involves connecting the GTC computer into a network with the polling computers at COAX and QUBE. The GTC computer would request the CATV computer to poll certain areas of their distributions. The CATV computers would schedule these requests along with their own polling requirements in such a way that the polling rates of all applications will be optionally fulfilled. When the areas of the plant specified by the city's application is selected by the CATV computer, the CATV computer would notify the TC center computer. The digital subband channel signals would be passed to RF receivers interfaced to the TC computer. The GTC computer would signal the CATV computer when it had completed receiving all the data desired from that area of the distribution. The GTC computer would be allotted a relatively short maximum time period to capture the data in each area so that the polling rates of all applications can be adequately satisfied. To provide this high speed performance, we recommend that a small high speed micro/minicomputer based system serve as a front end communications controller to the GTC main processor.

For the CATV systems which currently do not support subband digital communications, the GTC communications controller may initially provide the area switching functions which are currently being performed by COAX and QUBE computers. At such time that KBLE and ATC may upgrade their service to include a subband communication service, then the system configuration and control would revert to the same

scheme recommended for COAX and QUBE. Note that for KBLE and ATC to provide a subband digital return channel, the inclusion of return channel amplifiers, the inclusion of area RF switches for control of signal intrusion and multiplexing, and possible other plant modifications would be necessary. The configuration described above is illustrated in Figure 6.1.

The development of a digital monitoring application on the CATV distributions for all four cable systems require thorough systems design, the specification, selection and acquisition of appropriate GTC computer systems, the design and implementation of the software in both the GTC computers as well as additions to the software in the CATV computers, the procurement of the remote sensors or keypads for each of the applications, etc. This development will involve very substantial costs. Therefore, the project team does not envision this development during the initial startup period of the GTC and interconnect system.

6.3 Summary of Production Requirements

The analysis of the production requirements for each of the possible applications listed above is summarized in the tables below. The production equipment already ordered by the city will be enough to get started in GTC productions. Beginning year four, $15,000 is budgeted for additional maintenance and production equipment. Also year four marks the introduction of the videotext applications. The beginning of the requirements analysis and design of the digital communications applications and the planning for computer system procurement begins in year four and extends beyond the first five years.

Table 6.2 summarizes the production requirements by class of service. Table 6.3 develops the summary of total production team requirements based on information in Tables 6.1 and 6.2.

The analysis of the production requirements for the applications listed above suggest that one production team of 7 people would be adequate to support the production requirements forseeable over the next five years. In addition to the production team, administrative

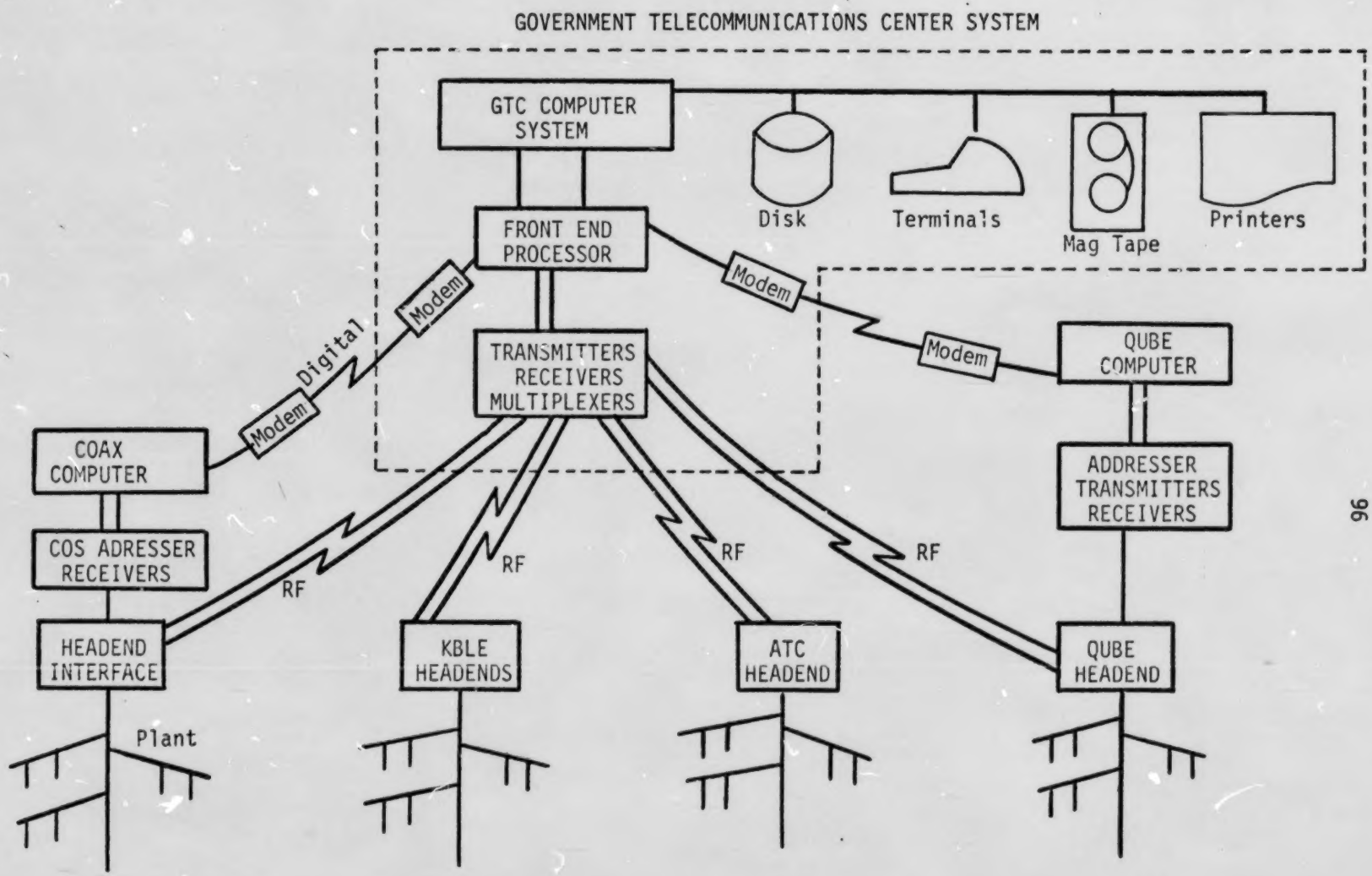

FIGURE 6.1 INTEGRATION OF DIGITAL COMMUNICATIONS ON CATV NETWORKS

Table 6.2 Summary of Production Requirements by Class

Year → Production Class	Hours in Use/Month 2	3	4	5	Team Size	Equipment % Utilization/Mo. 2	3	4	5
3C	14	28	58	70	7	6	13	26	31[1]
1C	0	0	.16	.16	4	0	0	0	0
TP	0	0	0	0	1	0	0	0	0
CG	193	214	214	214	1	86	96	96	96[2]
VT	0	0	7.5	19	1	0	0	0	1
TC	0	0	0	0	0	0	0	0	0
EM	0	0	0	0	0	0	0	0	0
CL	0	0	0	0	0	0	0	0	0
LI	0	0	0	0	0	0	0	0	0

[1] Based on 8 hours/day/month.

[2] Based on 24 hours/day/month of availability

Table 6.3 Manpower Team Requirements

Production Class	Hours/Month Required for Team 2	3	4	5	% of Available Hours/Person 2	3	4	5 (3)
3C	14	28	58	70	8	17	35	42
1C	0	0	.16	.16	0	0	0	0
TP	0	0	0	0	0	0	0	0
CG	55.4	76.4	76.4	76.4	33	46	46	46
VT	0	0	7.5	18.75	5	11	11	11
TC	0	0	0	0	0	0	0	0
EM	0	0	0	0	0	0	0	0
CL	0	0	0	0	0	0	0	0
LI	0	0	0	0	0	0	0	0

(3) Average available hours/month is 167.

and clerical personnel would be required to manage the Center's activities, interface with the various government, institutional, and public sectors which may wish to utilize the broadband communications capabilities, and schedule the production and broadcast events. Finally, a crew of maintenance technicians would be required to service the production, master control, and cable distributicn plant. The coordination of plant maintenance of the interconnect cable system between the Departments of Energy and Telecommunication and the Division of Traffic Engineering is recommended to minimize the cost of providing around the clock maintenance service of both cable systems. A possible GTC staff organization is illustrated in Figure 6.2.

Finally, Figure 6.3 suggests a moderately ambitious schedule for production development and Table 6.4 provides the corresponding projected production costs.

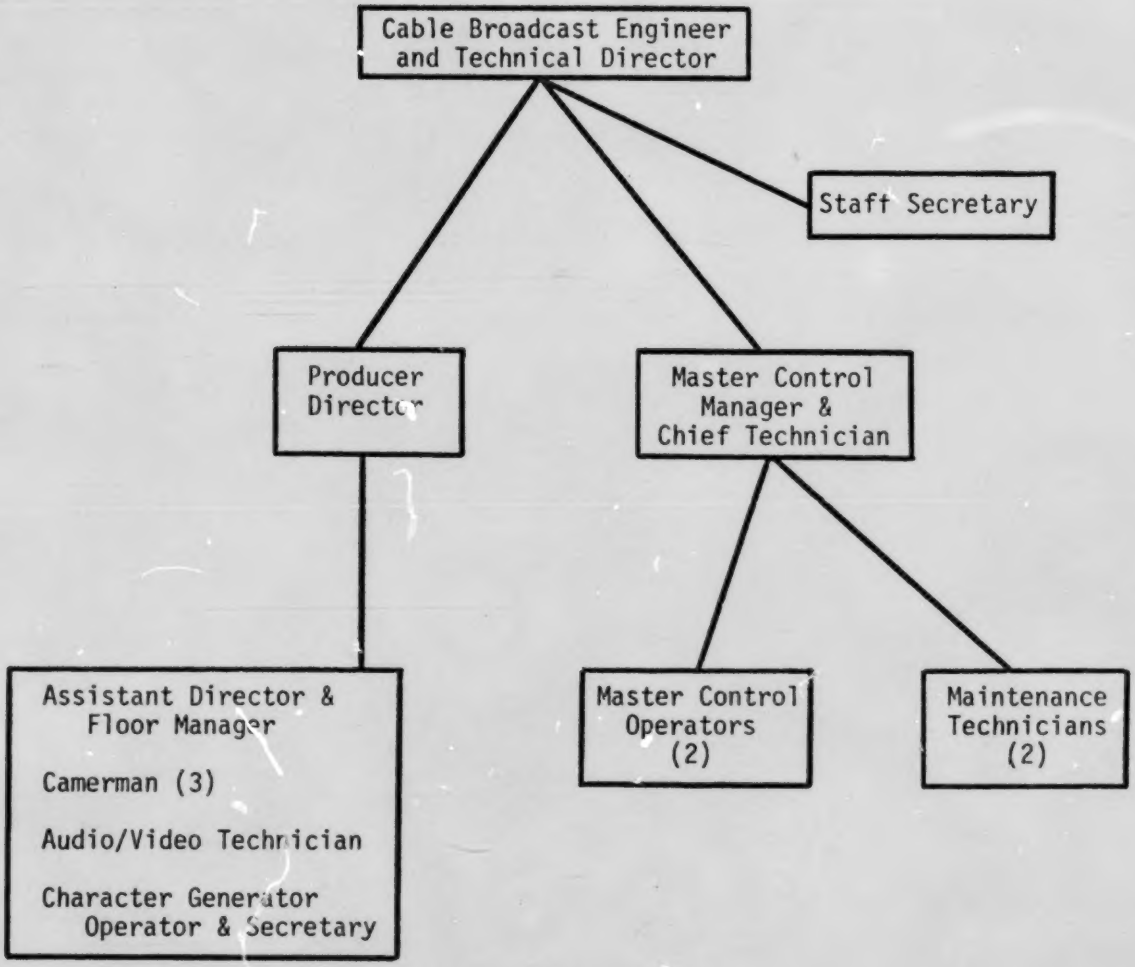

FIGURE 6.2 TOTAL PERSONNEL REQUIREMENTS

Major Task Description	1	2	3	4	5	Beyond 5 years
1. Interconnect Construction	◄——►					
2. Introduction of Live, Taped, and Simple Textual Programs	◄———	———►				
3. Expansion of Production Volume			◄———	———	———►	
4. Introduction of Videotext Applications				◄———	———►	
5. Expansion of Videotext Applications					◄———	———►
6. Requirements Analysis for Teleconferencing and Electronic Mail				◄———	———►	
7. Requirements Analysis for Digital Communication Applications on CATV Networks				◄———	———►	
8. Functional Design of Teleconferencing and Electronic Mail					◄———	———►
9. Detailed Design and Implementation of Teleconferencing and Electronic Mail						◄——— ———►
10. Functional Design of CATV Digital Communications Capability					◄———	———►
11. Detailed Design and Implementation of CATV Digital Communication Capabilities						◄——— ———►

FIGURE 6.3 GOVERNMENT TELECOMMUNICATIONS CENTER
PRODUCTION DEVELOPMENT SCHEDULE

Table 6.4 Government Telecommunications Center Development Projected Costs

Years →	1	2	3	4	5
1. Production Equipment (Initial Procurement)	(Production Equipment of $93K Already Acquired)				
2. Personnel					
TC Director	22K	24K	26K	29K	32K
Director/Producer	--	20K	22K	24K	26K
Floor Manager/Asst. Director	--	17K	19K	21K	23K
Chief Technician	17K	19K	21K	23K	25K
Camera Operator 1	--	13K	14.5K	16K	18K
Camera Operator 2	--	6K partime	14.5K	16K	18K
Camera Operator 3	--	3K partime	6K p.t.	8K p.t.	9K p.t.
Technician - Plant Maintenance	--	15K	16.5K	18K	20K
Technician - Audio Video/Maintenance	--	13K	14.5K	16K	18K
Technician - Maintenance	--	13K	14.5K	16K	18K
Secretary	10K	11K	12K	13.5K	15K
Character Generator Operator/Secretary	--	9K	10K	11K	12K
Master Control Operator 1	--	13K	14.5K	16K	18K
Master Control Operator 2	--	13K	14.5K	16K	18K
System Engineer	40K	--	--	--	--
3. Fringe Benefits (20%) (excluding System Engineer)	10K	36K	43K	47K	52K
4. Production & Maintenance Equipment Additions	--	--	--	15K	--
5. Computer System Design and Needs Assessment	--	--	--	50K	100K
6. Videotext Systems	--	--	--	Unknown	Unknown
TOTAL	$59K	$216K	$256.5K	$347.5K	$413K

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APPENDIX A

RECOMMENDATIONS FOR PUBLIC TELECOMMUNICATION POLICY STRUCTURE: A CITY-WIDE CABLE TELEVISION SERVICE IN COLUMBUS, OHIO

Prepared for the
City of Columbus
Department of Energy and Telecommunication
by
Thomas A. Muth, Ph.D.

APPENDIX A

RECOMMENDATIONS FOR PUBLIC TELECOMMUNICATION POLICY STRUCTURE: A CITY-WIDE CABLE TELEVISION SERVICE IN COLUMBUS, OHIO

The foregoing analysis indicates that initial interconnection of the existing cable television systems can introduce first city-wide cable television service to Columbus. Public policy necessarily associated with the service requires detailed development and will constitute a continuing, dynamic socio-political process in the community.

Public telecommunication policy will succeed in Columbus if it can comprehend, accommodate, organize and order three principal social, political, and economic sectors in the community. Policy must address, as described in Reports No. 1 and No. 2, the needs and demands of the social community at large, the general political government and economics supporting cable television firms serving the community.

This implies need for development for a dynamically modeled, systematically operating entity that can interact with the three sectors and their constituents in a flexible but controlled manner. Policy of this entity must have a communication-optimal perspective. That is, the entity must develop and maintain policy that enhances communication generally, and in particular for the three principal sectors most proximately involved with city-wide cable service.

This relationship is illustrated in Figure A-1.

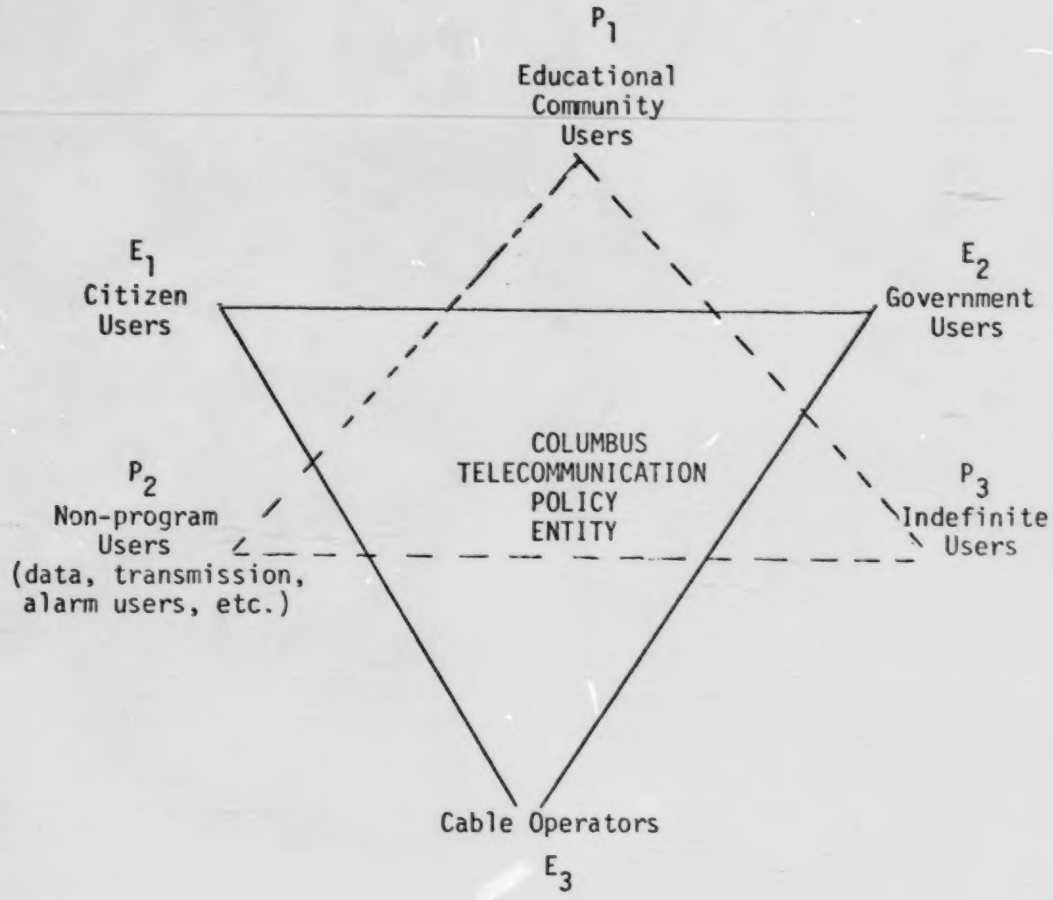


FIGURE A-1. Illustration of City-Wide Cable Television Users as Related to a Columbus, Ohio Telecommunication Policy Entity

E_1, E_2 and E_3 either currently exist or are obvious immediate users of the service.

P_1, P_2 and P_3 are potential users and are included to illustrate the need for an expansive, dynamic telecommunication policy entity model for the Columbus community.

It may be observed that the structure may be expanded to meet virtually all foreseeable Columbus telecommunication policy Requirements

Meeting the essential tri-parte and more generalized need requires relatively independent policy, the principal concern of which is communication. Policy of this variety should eminate from an entity with a good measure of independence, yet one that is clearly dedicated to the immediate and general public concerns.

A number of entity models might be employed to accomplish the policy objectives for city-wide cable in Columbus. The following brief review of model options suggests the range involved.

(1) Executive Agency--A division of the executive branch, the Mayor's administration, organizes the policy effort. This would undoubtedly entail organization of a broad based citizens advisory or regulatory panel to provide ongoing input. This agency, in any event must be staffed to allow ongoing investigation of community communication need by systematic research as well as by citizen input.

(2) Semi-Autonomous Government Agency--Classically this entity is created by legislative action, by grant of Charter, etc. It is frequently a government surrogate, but can be established so that it functions in a relatively autonomous manner. Examples of this model might be the FCC or a Public Utility Agency. Generally in such instances the legislative branch defines the agency, and its duties, the executive controls nomination and the legislative approves appointments.

The control of such bodies may also be modified where the legislative arm chooses to have a general policy making body elected. This delegation of legislative power is usually employed where government has determined that specific functions require particular democratic attention. Conclusions such as these arise generally only after far greater experience and study of governmental objectives than can be accomplished in this report or in the immediate future

of cable telecommunication policy in Columbus. The possibility is noted here for completeness and as a future reminder for directions that cable service will probably assume.

(3) Semi or Quasi Private Entity--This model has been used in several instances in cable television policy in the last year or two.

A private non-profit firm or trust is created. This entity may be funded by several alternative means. It may be retained by government subsidy, by fees or contributions from cable firms, subscriptions from the general public or by a combination of these.

This entity could be a corporation or trust. The corporate board or the trustees could set general policy and rules for operation of the city-wide interconnected channel.

It could be modeled upon an entity such as COMSAT, the Corporation for Public Broadcasting, or any number of public broadcasting stations. The general purpose of the entity would be to encourage and organize operation of city-wide cable in Columbus.

As such, it would set policy and move toward varieties of implementation mechanisms. The entity could be directed to manage the city-wide service, or it could be allowed to secure outside management while retaining specialized telecommunication policymaking for itself.

A wide variety of choices can readily be associated with this model.

(4) Private Profit-Making Entity--Finally, there exists the alternative of a private profit-making model. The City is in a position to treat the interconnection of cable systems and also service or services that can be transmitted by such systems as proper ground for private enterprise. In this context the City could merely license one or more firms to use the City streets and ways to transmit and/or exchange programs and other communication between

cable systems.

Entities or firms of this variety should be recognized to have at least two distinct functions: (1) to transmit information and (2) to serve as a source or originate program or other substantive messages or services for exchange.

One or more firms may provide one or more of such services, but should be noted that the degree to which the entity is dedicated to "transmission" may result in its designation as a carrier under existing Federal and other policies. Thus, if transmission is to be the principal or essential function or service, the issue of common and other communication carrier policy regulation and law must be examined by legal counsel.

If policy or even provision of city-wide program or origination information service transactions are to be an essential function of the entity, the carrier issue is reduced, but still legal counsel should be consulted on the specific status of this type service.

Although some of the described confusion of the nature of the city-wide origination service may arise, it is certain that long range, continuing systematic analysis can produce clear working distinctions between varieties of services. These working distinctions can ultimately define classes and categories of service transmittable by cable. This process can engender forms of cable communication service that heretofore have been ignored, unknown or simply undeveloped.

Thus a private profit entity is feasible, but should be carefully compared with other models outlined in this section.

Conclusions and Recommendations Concerning Policymaking Models Presented in this Report

The general nature of the model should be apparent. An entity sufficiently separate from existing or obvious interest groups (cable operators, municipal government and citizen users) should be developed. It must possess good measure of policy making authority. It must be able to change its structure. It must have ready access to specialized knowledge on the various aspects of telecommunication and cable development: engineering, social results, economic consequences, and legal status. It must equally have pragmatic common sense general information on the practice and actual potential for telecommunication development. It must develop, execute, maintain, revise and continuously adjust telecommunication policy for the city wide cable service of Columbus.

On balance it seems that this role can be most deftly accomplished by a private non-profit entity directed by a broad based board of Columbus area citizens. Thus, it is recommended that the City of Columbus initiate a non-profit corporation chartered for the purpose of developing policy to enhance, encourage, and support cable and associated city wide telecommunication service.

It is anticipated that the entity would establish rules or by-laws, based upon systematic evaluation of a community communication needs and demands. This is a process that entails integration of analysis from technology, sociology, psychology, social-psychology, communication science, law and ethics. It is obviously interdisciplinary, somewhat complex, but clearly not a process beyond the present reach of telecommunication practice in the Columbus community in the latter fifth of the Twentieth Century .

A well-conceived telecommunication policy body, initially concentrating on city-wide cable television service, will directly and quickly lead implementation of optional community cable service that will readily match the advanced technological service in the Columbus community.

APPENDIX B

CONSTRUCTION, INSTALLATION, AND TEST SPECIFICATIONS

APPENDIX B

CONSTRUCTION, INSTALLATION, AND TEST SPECIFICATIONS

Construction Specifications

A. Types of Materials --

i. All forged steel and iron hardware used shall be hot dipped galvanized.

ii. All steel support messenger used shall be seven wire supporting strands, 1/4 inch extra high strength, ASTM Class A Galvanized.

iii. All wood products used shall be pressure treated. Approved preservatives are: Creosote or Pentachloraphenol.

iv. All other hardware materials not specified above shall be corrosive protected to the environment. These materials will be of the highest quality with a long-life expectancy of twenty (20) years.

v. In no case shall friction or plastic tape be used to secure cables or hardware to each other or to support messenger for a permanent attachment; cable support straps or tie-raps shall be used for permanent attachments.

B. Anchors (Where authorized and applicable) --

i. All installation of anchors shall be coordinated with the utility companies to insure that no damage will be incurred to their underground services.

ii. Contractor shall be held responsible for any damage to any underground facilities resulting from his attempt to place equipment or materials while constructing the system.

iii. Anchors and guy wires shall be installed and tensioned prior to sagging any support messenger.

iv. Temporary guys shall be installed at the end of any messenger run that is proposed for extension by the Contractor before sagging in messenger, with permission of utilities.

v. Any anchor rods which are found to be distorted, i.e., bent, twisted, the eye damaged, will be replaced upon request at Contractor's cost.

C. Guy Wires (Where authorized and applicable) --

i. All guy wires shall be installed and tensioned prior to sagging any support messenger.

ii. The Contractor shall be responsible for damage to any utility poles or peripheral equipment caused by raking poles.

iii. All guy wires shall maintain proper clearances to ensure safe passage of vehicles and persons.

iv. Guy guards shall be installed whenever the guy wire presents a hazard to persons, vehicles, or animals who are likely to come in contact with guy wires accidentally. Any guy more than 3' from other guy guards shall have a new guy guard installed.

v. All guy guards shall be yellow plastic unless otherwise specified.

vi. One quarter inch extra-high strength messenger shall be used in all locations unless otherwise specified by the utilities or other codes.

vii. Five sixteenths inch high strength strand shall be used for all railroad and highway crossings over 400' or when specified by Railroad or Highway Departments.

viii. Sidewalk guys shall be used in all locations where head room of eight feet is not available using normal guy wire installation techniques.

ix. Span guys shall be used in locations where it is not feasible to install an anchor.

x. Two bolt guy clamps or preformed dead ends shall be used on all guys at the anchor rod to allow for proper tension and maintenance.

xi. Serving sleeves shall be used on messenger ends where two bolt clamps are used and strand tail is exposed. Sleeves shall be crimped.

xii. Strand shall be continuous to anchor where possible. Where continuous strand is required to the anchor rod, a continuity bond shall be used.

D. Bolts -- Pole Attachments

i. All through bolts and eye bolts shall be of five-eighths inch construction.

ii. At no time shall there be more than two inches, or less than two full threads, of bolt extending beyond the out-

side of the square nut after the strand clamp has been securely fastened.

E. Suspension and Cross-Over Clamps --

i. All suspension clamps shall be of the three bolt flat back variety.

ii. The lip of the suspension clamps shall always be below the through bolt and facing the pole.

iii. Cross-over clamps, especially made for one-quarter inch messenger shall be used. Use of bushings or shims are not permitted to make a secure connection on standard cross-over clamps.

iv. Curved suspension clamps shall be used for tangent pulls up through thirty-five degree angles as follows:

(a) Straight run up to ten degrees, use a straight suspension clamp.

(b) Any tangent pull from ten degrees to thirty-five degrees, use a curved suspension clamp.

v. All tangent pulls greater than thirty-five degrees shall use dead end construction techniques.

vi. Curved suspension clamps shall always be placed on the threaded end of a through bolt. Dead end construction attachments may be attached to opposite end of through bolts.

vii. Introducing tangent pulls at strand cross-overs shall not be done using normal cross-over clamps. Where change of direction is necessary, at a cross-over, to make lateral clearances you shall use one three bolt

suspension clamp connected together with a 5/8" x 4" bolt and three nuts.

F. Cross Arms, Extension Arms and Guard Arms
(Where authorized, and applicable)

i. Wooden, hot-dipped galvanized or epoxy arms shall be used when necessary to make lateral clearances around trees and obstructions.

ii. No wooden cross arms shall be installed on concrete poles; it will be necessary to use steel or epoxy arms.

iii. Where it is necessary to install an arm on a pole that has a tangent pull, a steel or epoxy arm shall be installed.

G. Steel Support Messenger --

i. All guy wires shall be tensioned prior to sagging in any support messenger. All support messenger splices will be placed at poles -- no strand splices allowed in mid-span.

ii. One-quarter inch extra-high strength messenger shall be used in all locations unless otherwise specified by the utilities or other codes.

iii. Messenger shall be under tension at all times when being pulled in.

iv. All precautions shall be taken while pulling messenger to:

(a) Prevent damage to other utility equipment and wires;
(b) Maintain clearances across roads and driveways and not jerk or flop messenger up into power.

v. Extreme care must be observed when the messenger pulled with a vehicle.

vi. False dead end messenger attachments shall be used in all locations accompanied with guying where great differences in pulling tensions are required to maintain proper clearances and prevent raking of unguyed poles or placement of a dead end anchor is not possible on the final pole.

vii. Where slight differences of pulling tension are required between pole spans, suspension clamps shall be tightened after messenger is sagged in.

viii. All suspension clamps shall be tightened upon completion of installation of cable.

ix. Use Jackson strand brake (pole mount) or equivalent at all major intersections.

x. The CATV strand shall always be attached to the same side of the pole (field or street) to which the telephone strand is attached. Where no telephone strand is attached, the CATV strand, cable and associated equipment shall be mounted on the street side of the pole.

H. Moulding and Guards -- *(Where authorized, and applicable)*

i. Wood or plastic moulding shall be installed over the bottom eight feet of a vertical ground in all locations where accessible to the public.

ii. Eight feet of steel, rigid PVC or "U" guard moulding shall be installed over all underground cables making a vertical rise to overhead plant.

iii. Plastic tree guards shall be placed in all locations where coaxial cables will be in contact with a foreign body which will apply pressure, shock, or rubbing action to damage coaxial cables over a period of time.

iv. Wood or metal moulding shall be banded around any messenger that is in tight contact with tree limbs or trunk. This will prevent tree from growing around messenger.

I. System Bonding and Grounding --

i. The CATV strand shall be bonded to the telephone strand and/or other existing pole grounds in accordance with the utility company pole lease agreement, except that there shall be a minimum bonding between parallel CATV and telephone strands at the first, last, and every tenth pole.

ii. The CATV strand shall be grounded at each power supply location using a 5/8" x 8' ground rod, driven its full length plus six (6) inches below the ground and #6 soft drawn, bare copper wire. All ground rod clamps shall be treated with an oxide-inhibiting compound before being buried.

iii. On all bonds, strand-to-strand and strand-to-copper -- the clamp used must be of a suitable type that will prevent corrosive action between dissimilar metals. All bonding clamps and equipment bonds shall be treated with an oxide-inhibiting compound.

iv. The clamp must be installed in the manner prescribed by the manufacturer.

v. When installing the clamp, the cut end of the conductor must not protrude beyond the edge of the clamp.

vi. The bonding clamp must be installed directly to the supporting strand, and not on any part of the dead-ending hardware.

vii. All bonding and grounding conductors must not have any right angle bends. All bends must be as gradual as possible and still maintain an orderly appearance.

viii. All dead-end bonds or grounds must be completed along with the installation of strand.

ix. When the suspension strand is being placed on poles carrying power wires, it should also be grounded to a low-impedance ground during the installation procedure. A grounding roller should be used for this purpose. Grounding of the strand during the placing operation and after final tensioning shall usually be at the first, last, and at every tenth pole. Where the power company multi-grounded neutral is not available, the ground wire should be connected to a ground rod driven into the ground at the base of the pole.

x. NEVER GROUND TO GAS MAINS. THIS IS A VERY DANGEROUS PRACTICE.

xi. Power Company Vertical Bonds

The CATV strand is to be bonded to the power company verticals at the nearest adjacent pole containing a power vertical in each strand direction from a desired location.

DEFINITION OF "DESIRED LOCATION"

1. All amplifier stations
2. AC power supplies
3. Strand cross-over
4. Strand tee
5. Strand dead-end
6. False dead-end

NOTE:

1. If the nearest adjacent pole containing a power vertical is more than five poles away from the "Desired Location" in any strand direction, a ground rod should be driven at the base and connected to the CATV strand with a #6 soft drawn copper wire.

2. CATV strand continuity must be maintained through all cross-overs, tees, false dead-ends and down guys.

3. Bonds must be attached to power company's existing verticals using a #6 split bolt connector with a K1 weaver clamp.

J. Power Supply Installation --

i. See attached drawing for installation of power supplies (except where required otherwise by the utility company pole lease agreements or other codes and ordinances).

ii. Power supplies may not be installed on transformer poles.

iii. Power supplies may not be installed on poles where there is an underground riser conduit or capacitor control.

iv. Power supplies may not be installed on poles where there is a line switch operating mechanism, fire alarm box, police signal box, traffic control box, or a meter unless the meter is for the power supply.

v. Power supplies shall be located throughout the system as required and shall be attached to the poles using standard 5/8" machine bolts and associated hardware.

vi. Power supplies shall be mounted twelve (12) feet above the ground except when required otherwise by the utility company pole lease agreements.

vii. Self-healing lightning arrestor #GE-9L15CCB007, or equivalent shall be installed at each power supply location line side of the service.

viii. The AC power connection from the weather head to the power supply shall consist of two #12 TW copper conductors enclosed in 3/4" galvanized, rigid conduit except when required otherwise by the utility company pole lease agreement or other codes and ordinances.

ix. The neutral side of the power drop shall be continuous and unfused. The neutral shall be bonded to the power supply, the cutout cabinet, and the meter base, if used, which in turn shall be grounded to the driven ground rod at the base of the pole on which the equipment is mounted. The power supply cabinet shall be bonded to the strand.

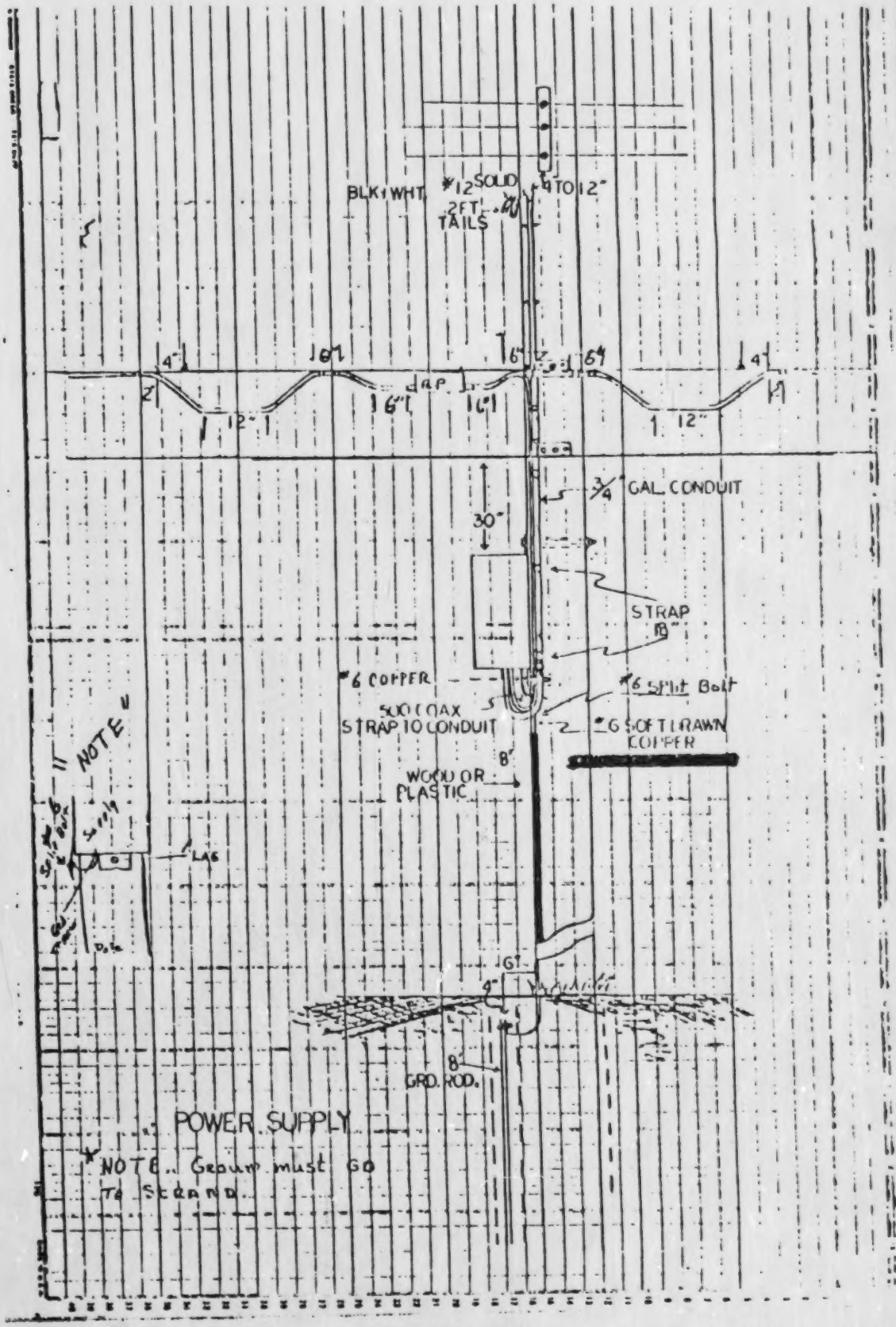
K. General Construction Practices --

i. When transporting cable or strand on trailers or trucks, be sure that all ends are stapled or tied down properly.

ii. The Contractor's personnel shall not leave waste in the field: cable reels, strand reels, cable straps, lashing wire, etc.

iii. The Contractor has the duty of providing for and overseeing all safety orders, precautions, and programs necessary to the reasonable safety of the work.

iv. The Contractor shall maintain at all times strict discipline among his employees and subcontractors.


BLK & WHT #12 SOLID 4 TO 12"
2FT. TAILS
4"
16"
16"
16"
16"
4"
12"
12"
DRIP
3/4" GAL. CONDUIT
30"
STRAP TO
#6 COPPER
#6 Split Bolt
SOLOFLEX STRAP TO CONDUIT
#6 SOFT DRAWN COPPER
8"
WOOD OR PLASTIC
"NOTE"
LAG
6'
9"
8'
GRD. ROD.
POWER SUPPLY
NOTE.. Ground must GO TO STRAND.

Coaxial Cable Handling and Installation Specifications

A. Specifications and Testing

i. All (100%) of the coaxial cable received shall be visually inspected to determine that the center conductor is securely bonded to the dielectric, that the aluminum sheath is tightly extruded to the dielectric, and that all other mechanical specifications are met.

ii. Physical and electrical specifications of all coaxial cable shall meet manufacturer's specified tolerance.

iii. All coaxial cable shall have a minimum structural return loss of 28 dB from 5 MHz through 400 MHz.

iv. Cable structural return loss shall be checked on both ends of each cable reel.

v. Coaxial cable used in this project shall be guaranteed to be of first quality material and workmanship. In the event of failure due to faulty material or defects in manufacturing, within one year after acceptance, the defective cable shall be replaced, without increasing the number of splices or connectors, at no cost to the city for labor or materials.

vi. Every reel of cable received at the construction site shall be tested and accepted before installation in the field, for:

(a) Structural return loss (5-400 MHz)
(b) Attenuation
(c) Footage Measurement

vii. Complete records of these tests shall be maintained and will be given the city at completion of each phase.

viii. Structural return loss measurements on cable shall be made with a suitable bridge and sweep generator.

ix. The cable footage will be measured by utilizing a TDR or equivalent.

x. Cable attenuation is measured by sweep frequency methods with a signal comparator switching the oscilloscope from test to reference and using a variable attenuator to determine by comparison the cable attenuation at various frequencies.

B. Handling coaxial cables --

i. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded when pulling in coaxial cables. A cable puller with strand brakes and swivel snaps shall be used when pulling all cables.

ii. Extreme care must be observed when pulling cable with a vehicle so as not to damage the cable.

iii. Cable rollers shall be used in the following locations to protect cable and property:

(a) Not more than 30-40 foot spacing between rollers.
(b) Over all roadways to ensure clearances.
(c) Over all telephone drops to prevent chaffing of drop.
(d) Over all driveways and in areas where persons could be hurt.

Note: Cables will never be allowed in rollers overnight.

iv. Corner cable rollers, especially designed for this purpose, shall be used for pulling coaxial cables around corners greater than thirty (30) degrees.

v. When pulling multiple cables, appropriate cable rollers shall be utilized to properly support and separate the cables so that, when lashed, the cables will maintain their approximate same position in the cable bundle throughout the entire length of the cable run.

vi. The lashing machine shall not be pulled with a vehicle at any time. The lasher shall lash the cable to the strand at an average of one-wrap per linear foot of strand.

vii. All trunk shall be double-lashed and any cable bundle consisting of three (3) or greater shall be double-lashed.

viii. Coaxial cable shall be smoothly installed. Loose lashing, twisting, weaving or air looping of cable shall be cause for rejection.

ix. Lashing wire shall be .045 inch, alloy 430 stainless steel.

x. Lashing cable support straps shall be zinc or stainless steel.

xi. The lashing wire shall be wrapped around the messenger before terminating in the lashing wire clamp.

xii. When securing lashing wire to the cable lashing wire clamp, care should be taken in securing lashing wire so that the clamp does not cut the wire, thereby releasing it. The lashing wire shall go between the two washers and be wrapped no more than one-half turn.

xiii. When lashing wire is securely fastened, the end of the lashing wire shall not be exposed. It shall be tucked inside of the cable lashing clamp.

xiv. Cable support straps and plastic cable spacers shall be placed as depicted in the attached diagram. All loop locations which consist of multiple cables shall have a band placed in the bottom center of the loop. All straps and spacers will be only hand tight!

xv. When any two or more cables of the same diameter are installed on the same strand, one or more cables will be identified with a waterproof tag/tracer and so indicated on the as-built map.

xvi. Cable shall be under tension, not to exceed that specified by its manufacturer, while being pulled and lashed to strand. Reel brakes shall be used on all cable trailers.

xvii. Contractor shall use forty-five (45) degree multi cable roller or equivalent at first pole of the proposed run to insure minimum stress and maximum protection to the cable as it comes off the reel. Cable shoes are not permitted.

xviii. The cable trailer shall never be placed any nearer to the pole than the height of the strand attachment to that pole. It is preferred that cable trailers be placed twice the strand height attachment from the base of the pole in order to prevent distortion of the cable.

xix. Cable guards will be utilized wherever cable contacts any object.

C. Forming coaxial cables --

i. All expansion loops will be of the flat bottom type with the "flat" portion being approximately 12" long (See diagram). Extreme care must be taken to insure that no expansion loop is pulled out due to removing the cable bender too soon. This practice shall be justification for replacing the cable at the contractor's expense.

These loops shall be formed using the Jackson Communication Corporation Unibend (3/4) #1084, or others as approved by the City.

ii. Trunk cable shall have full input and output expansion loops at all passive devices and amplifiers. Trunk cable shall have full loops at the input and output of all corners greater than 45 degrees. All splices shall have input and output loops. See diagrams.

iii. One expansion loop shall be placed in the trunk cable at the output side at every pole.

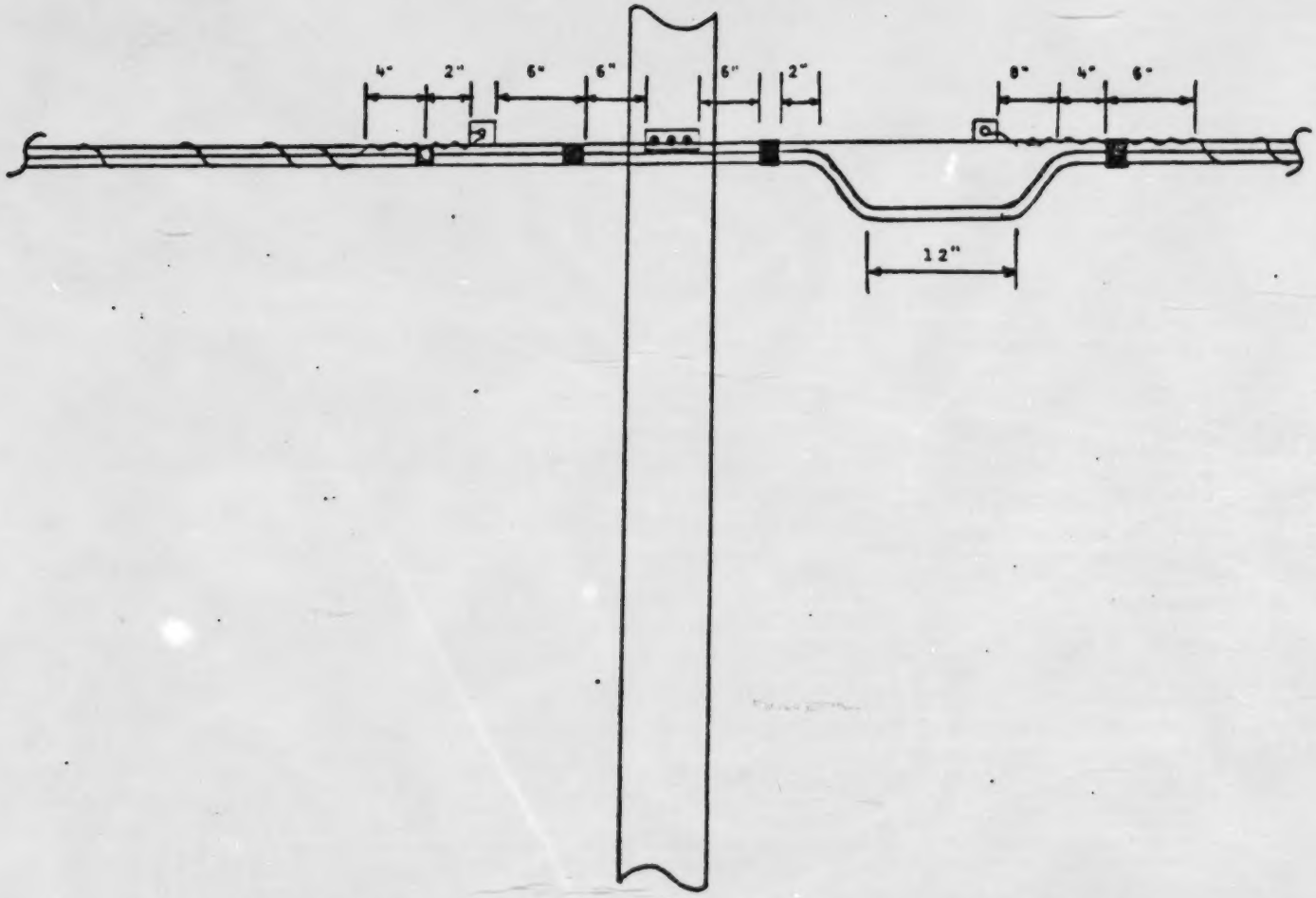
iv. City-approved stand-off brackets shall be used to secure all feeder distribution passive devices to support messenger in all locations where feeder cable parallels trunk line cables.

v. In the event a cable terminator is installed at the end of a trunk where no device exists, a cable spacer and strap shall be installed within two inches of terminator to avoid possibility of kinked cable. End of terminator shall be tilted up slightly.

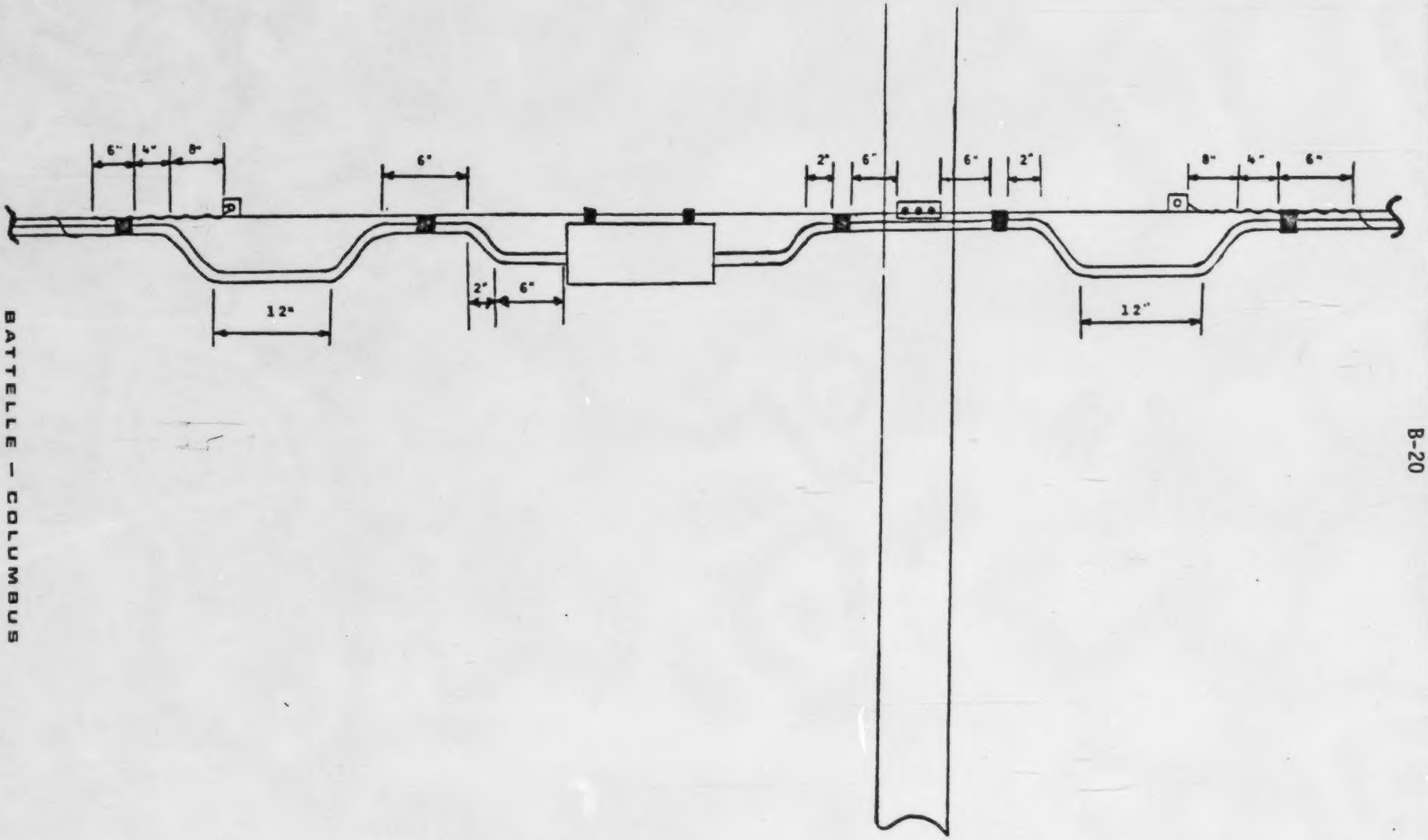
vi. Any active or passive devices at the end of a line will be terminated with a 5/8" entry terminator if the device is not already internally terminated.

vii. In cable tails are left, they are to be supported by a section of lashing wire, cable support strap or nylon tie no less than six (6) inches from the end of the cable. All exposed cables shall be capped or sealed to prevent moisture ingress prior to splicing. All cable ends of cable reels shall be capped or sealed at all times when not being used. Cable tails should be at least six feet long.

ix. All kinks in the cable shall be justification for replacing the cable at the contractor's expense (cable, material and labor).



TRUNK LOOPS



TRUNK, LINE EXTENDER
OR PASSIVES

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Splicing Specifications

A. Splicing parameters --

All splicing shall be in accordance with the following specifications and shall be in a uniform manner insuring good quality workmanship.

i. All connectors must use integral mandrel steel sleeves.

ii. The appropriate coring and cable preparation tools will be used in all splicing. When preparing cable for installation into equipment, there shall be no measurable change in the inside diameter of the cable.

iii. No splices or equipment will be allowed midspan. Midspan is defined as being inaccessible from the pole by a man on climbers. No active equipment shall be installed on slack spans.

iv. No cable-to-cable splice will be allowed closer than 300 feet to any active or passive device or other splice.

v. One trunk splice per 180 degree of angle pulled is the maximum allowed. One hundred and eighty degrees of pull shall mean two continuous 90° turns with a straight section of cable of undetermined length connecting the output of one 90° turn to the input of the second 90° turn. All other trunk splices must be approved by the city's field representative in writing prior to installation.

vi. Connectors-to-amplifiers and all other devices in the trunk system shall be protected against moisture in a manner specifically approved by the city. Approval of the method shall not relieve the contractor of full responsibility for proper application and workmanship of the materials in the manner specifically approved by the city.

vii. Silicone shall be applied to the threads and to the rubber "O" ring inside the connectors on all equipment to be mounted. No silicone is to be applied to the center conductor.

viii. Center conductors must be the exact length specified by the manufacturer of the equipment being installed. The center conductor shall be clean of any remnants of dielectric or foreign materials prior to installing cables in the device.

ix. Housing-to-housing adaptors and right angle fittings shall be used in all locations where possible. No reverse loops will be allowed.

x. All devices shall be strand-mounted or supported by a special stand-off bracket when the housing mount cannot be used, or when interconnected to another device by an entry-to-entry connector.

xi. All active and passive equipment will be situated in a manner that is accessible for service by a man on climbers from the pole.

xii. All expansion loops installed will be formed by using a Jackson cable bender or equivalent.

xiii. The splicer shall reform any expansion loop he has distorted in the process of installing a passive or active device to the specifications required. This can be accomplished by using the forming tool approved for the project.

xiv. A water gasket shall be installed in all amplifier, directional tap, power splitter, and power inserter lids and covers. Additionally, all amplifiers shall have an RFI-EMI conductive gasket, whether as part of

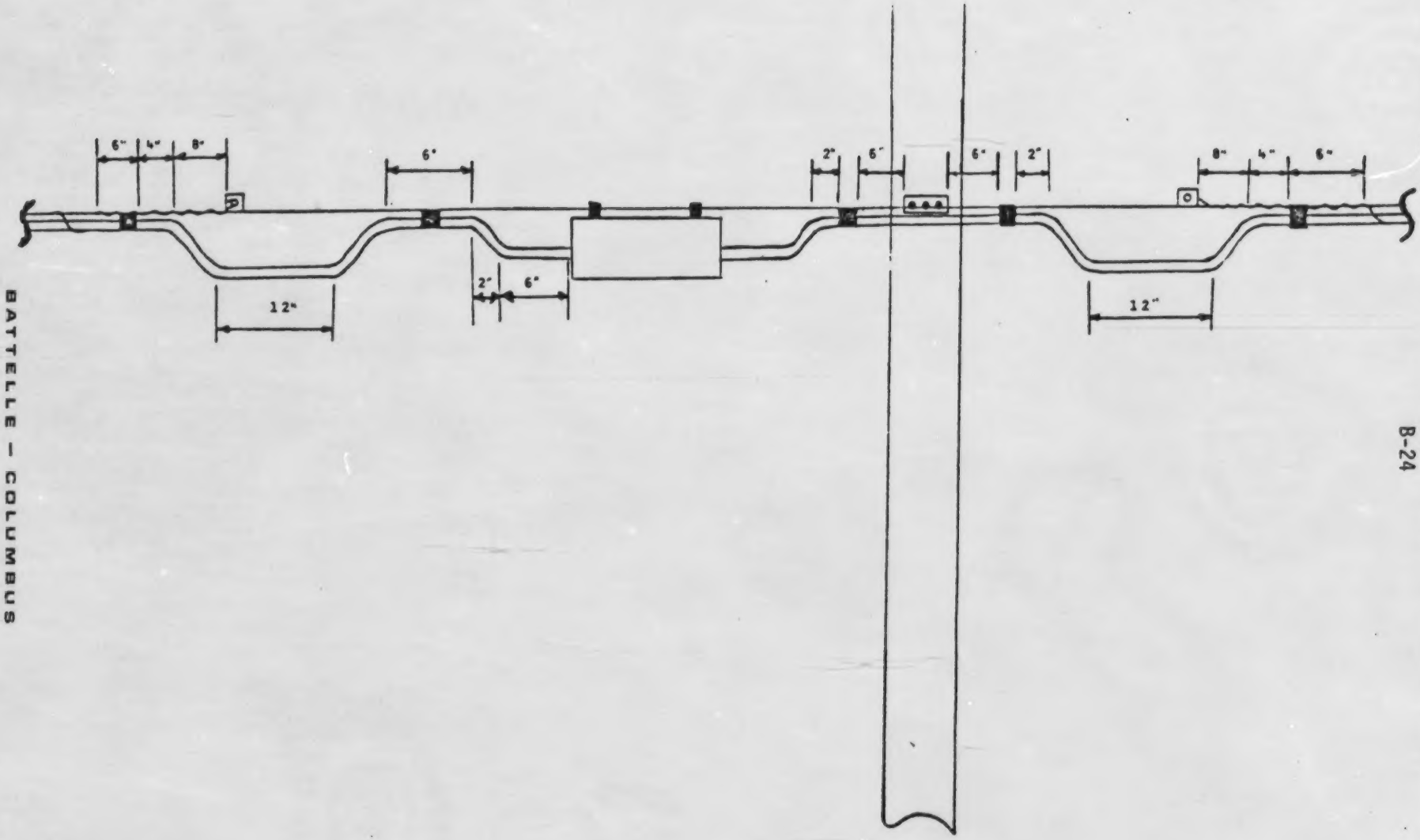
the water gasket or as a separate gasket.

xv. Metal terminators with the ground end of a 75 ohm resistor soldered to an F connector shall be installed on all tap ports. Port threads will be lubricated with silicone or equivalent prior to installing terminators.

xvi. If connector or splice pull-outs occur at an average rate greater than one half per strand mile of system built during the first twelve months following acceptance, the contractor shall take remedial steps and shall continue to be similarly responsible.

xvii. All torques as specified by manufacturers shall be used in tightening down all amplifier lids, passive device covers, seizing screws, and connectors. The use of a torque wrench is recommended.

xviii. The contractor shall present the city with a letter from each manufacturer specifying the torque to be used on their respective equipment.



TRUNK, LINE EXTENDER
OR PASSIVES

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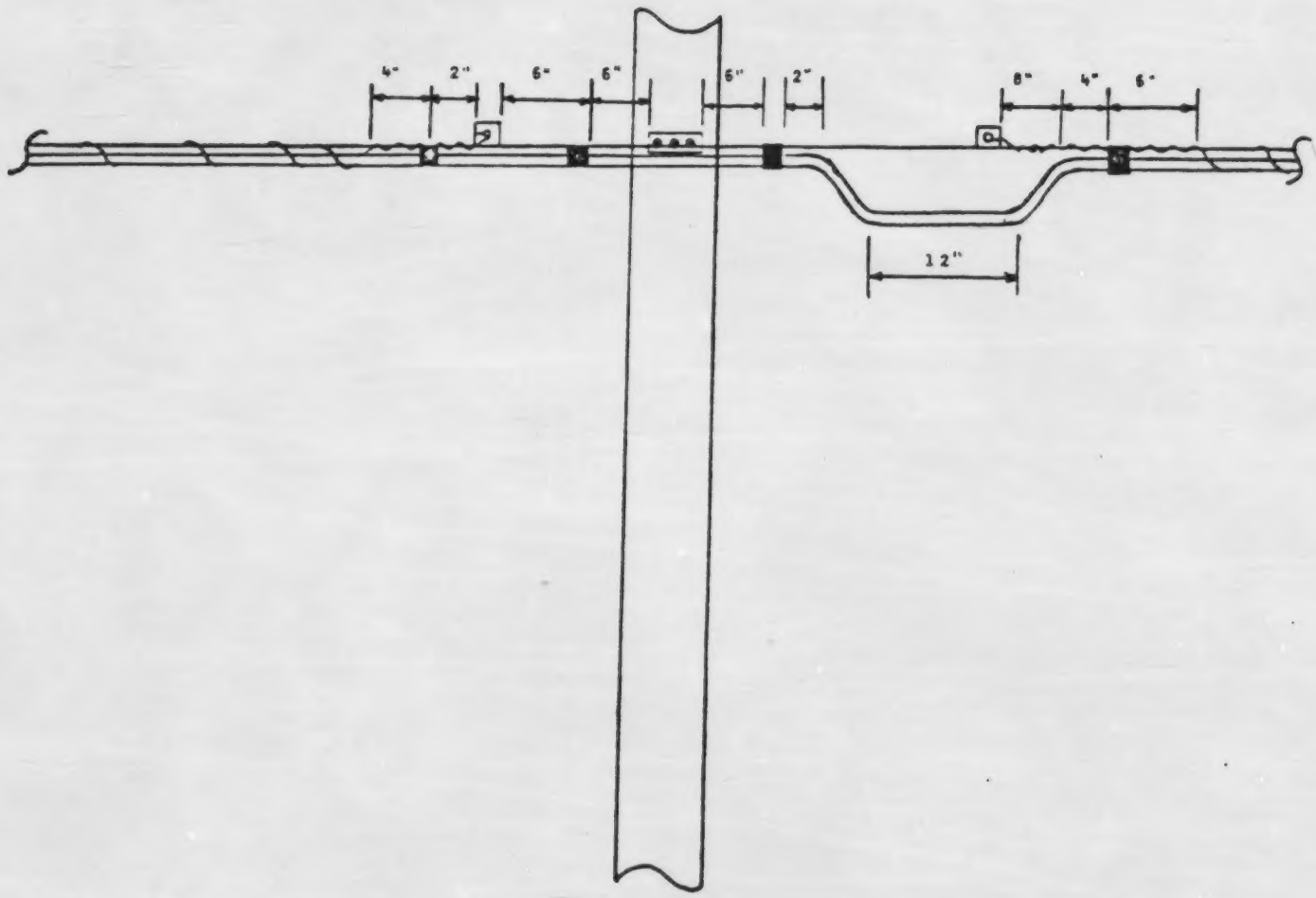


TRUNK LOOPS

General Contractor Responsibilities

The contractor will undertake to furnish the following services, materials, and to perform the work necessary to construct the city's interconnect system. The work shall be performed and material provided in accordance with the system specifications.

A. Engineering services --

i. The contractor shall provide engineering services to complete the interconnect distribution system, to provide proof-of-performance tests and to train the city's personnel.

ii. The contractor will provide engineering services to design an interconnect system as specified in the system specifications.

iii. The contractor shall also provide for contruction, energization and balance and proof-of-performance testing of the system.

B. System design --

The contractor shall provide a system design in accordance with the total capability as outlined in the system specifications. Design will include an electronics and strand layout including power locations. Sufficient sets of each type of map so prepared will be provided in order that the work may be completed. System design will also include the preparation of a Bill-of-Material for the equipment necessary to complete the system. All auxiliary items including connectors, coaxial cable, terminators and other active and passive electronic equipment necessary to complete the trunk will be included in the Bill-of-Material. The city reserves the right to specify and inspect products not furnished by the city to insure quality and compatability of components employed in the system.

C. Energization and balance --

i. The contractor shall provide or be responsible for sufficient personnel to energize the trunk system. This effort shall include the activating of all system power supplies, selection of proper amplifier transformer taps for adequate B+ regulation and system troubleshooting where necessary to insure full and proper system operation.

ii. The contractor will provide or be responsible for sweep balancing and alignment of the trunk system. Alignment and balance shall include input and output tilt and level adjustment of all trunk amplifiers installed during the proposed construction.

D. Personnel training --

The contractor will provide a field engineer to train the city's technicians in the operation and maintenance of the system. Training will include amplifier adjustments for system setup, including system sweep balancing techniques, system troubleshooting techniques and proper amplifier checkout procedures.

E. System acceptance testing --

The contractor shall provide a field engineer, field technician and test equipment to conduct system acceptance tests of the constructed system. These tests shall be designed to demonstrate that the system, when completed, is properly balanced and operating within the specified system performance standards. All testing will be conducted in accordance with the recommended proof-of-performance test procedures.

F. Correcting work --

When it appears to the city during the course of construction that any work does not conform to the provisions of the contract documents, the contractor shall make necessary corrections within ten (10) days so that such work will so conform and, in addition, will correct any defects caused by faulty materials, equipment or workmanship in work supervised by him or by a subcontractor.

G. Subcontracts --

The contractor agrees to furnish the city, prior to the execution of this contract, a list of names of subcontractors to whom he proposes to award the principal portions of the work to be subcontracted. A subcontractor, for the purposes of the contract, shall be a person with whom the contractor has a direct contract for work at the project site. The contractor agrees not to employ a subcontractor to whose employment the city reasonably objects, nor shall he be required to hire a subcontractor to whose employment he reasonably objects. All contracts between the contractor and subcontractor shall conform to the provisions of the contract documents, and shall have incorporated in them the relevent provisions of this contract.

H. System acceptance testing --

i. Following completion of installation of the system and at least ten (10) days prior to the date the contractor commences acceptance testing for said system, the contractor shall mail or cause to be delivered to the city's address a Notice of Testing. The city is required to have a representative observe and sign the test results. Upon completion of such testing, the contractor shall provide the city with a Notice of Completion. The city is required to execute and

return to the contractor a Notice of Acceptance.

ii. Within thirty (30) days after the system is accepted by the city, the contractor shall deliver to the city:

(a) One set of Mylar reproducible and two sets of blue line prints dated and marked "As-Built" containing an electronic, cable and strand layout of the accepted system. The "As-Built" maps shall show:

(1) Any changes that have been made which were not specified on the original strand and/or design print.

(2) Locations of all splices.

(3) Locations of all city vertical grounds, telephone bonds, and power bonds.

(4) All locations where city has an anchor or down guy.

(b) One copy of the amplifier sheets indicating the signal levels for the pilot carrier frequencies at the input and output of each amplifier station, forward and reverse where applicable, pad and equalizers used, AC readings, sweep frequency response pictures for the first, last and every fifty trunk station.

(c) One copy of the system test data sheets.

I. Spare and test equipment --

The contractor will recommend for purchase by the city a quantity of spare parts and test equipment for operations and maintenance

of the system. The contractor agrees to maintain the capability to provide replacements for the contractor built equipment of the system for a period of five (5) years from the date of completion of the system.

J. Title and risk of loss --

Prior to final or interim acceptance of the system or system portion by the city, the contractor shall, at all times, retain title to and bear risk of loss of materials and equipment provided by the contractor. From and after said final acceptance, the city shall be solely responsible for the risk of loss of the system.

K. Warranty --

The contractor warrants that all work under the contract documents will be performed in a workmanlike manner and that all material furnished by the contractor shall be free from defects in workmanship, and, for a period of one (1) year following completion of all construction, the contractor will, at its own expense, correct all defects which may arise therefrom.

L. Safety precautions and programs --

The contractor has the duty of providing for and over-seeing all safety orders, precautions, and programs necessary to the reasonable safety of the work. In this connection, he shall take reasonable precautions for the safety of all employees and other personnel performing the work, all work and materials incorporated in the project, and all property and improvements on the construction site and adjacent thereto, complying with all applicable laws, ordinances, rules, regulations and order.

M. Discipline and employment --

The contractor shall maintain at all times strict discipline among his employees and subcontractors, and he agrees not to employ for work on the project any person unfit or without sufficient skill to perform the job for which he was employed.

N. Compliance with applicable laws and regulations --

The contractor agrees to comply with standard Ohio utility practices, pole line agreements, franchises, state statutues and regulations, city or county ordinances, the National Electrical Safety Code and such other regulations as may be applicable for the proper construction of said system. Deviations from such construction practices will be accomplished only on written order from the city.

O. Information furnished to be confidential --

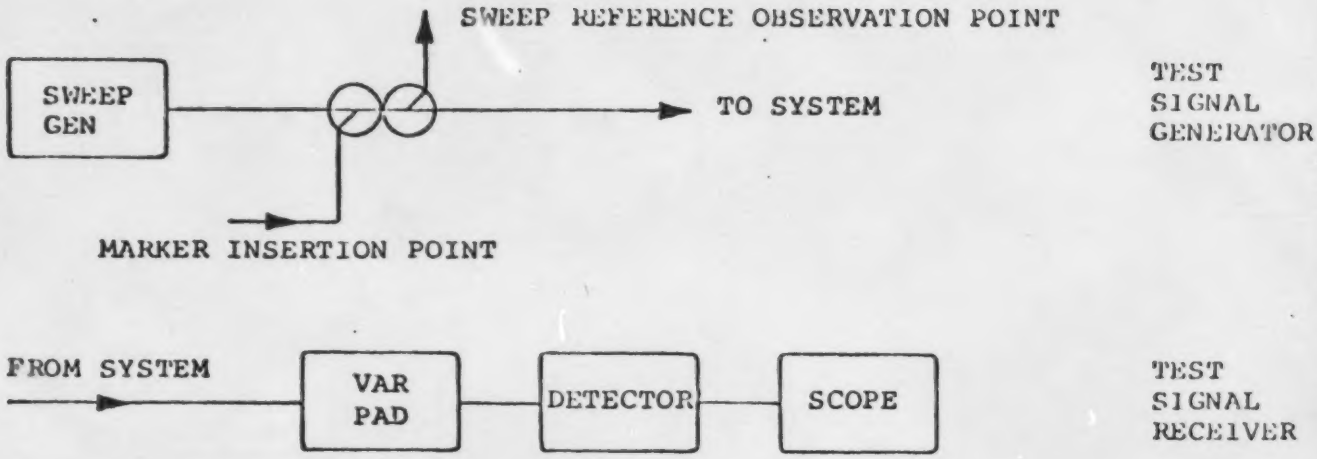
All information, whether printed, written or oral, in answer to special inquiry or voluntarily furnished by city or contractor, their agents or employees, shall be held in confidence and for their business only.

Recommended System Proof-of-Performance Test Procedures

A. General

This section establishes the recommended test procedures used in measuring system performance. All test equipment used in these procedures must be in good operating condition with current calibration. Deviations from these test procedures must be approved by the city.

#1 FREQUENCY RESPONSE



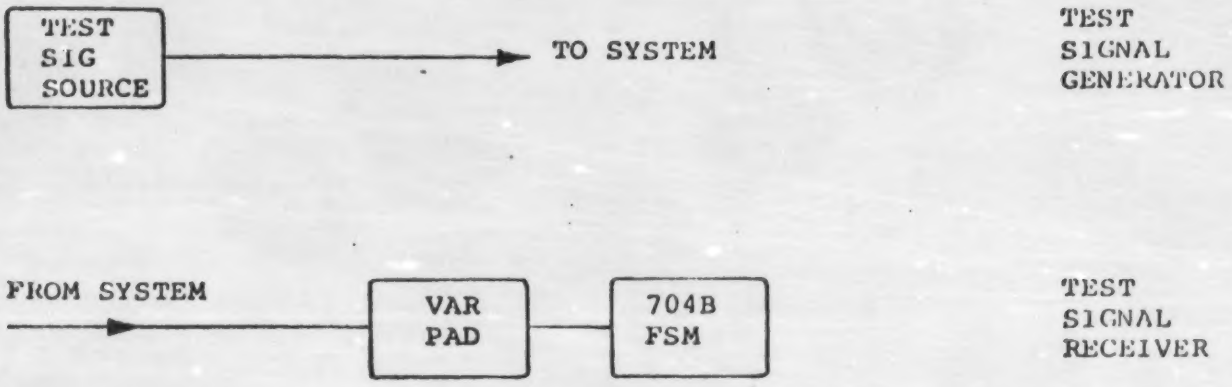
Procedure:

The sweep generator sweep center and width are adjusted to provide a swept signal wider than the passband of the cascade under test. A marker generator provides markers at selected points in the passband. The sweep generator output amplitude is adjusted to give a convenient reference level as observed on the receiver while connected to the sweep reference observation test point with the oscilloscope adjusted for maximum vertical deflection sensitivity.

The reference is drawn on the scope face. Two additional reference traces + 1.5 dB from the reference level are also obtained and drawn by adjusting the pad.

At the system test point, the sweep receiver is connected. The system deviation from ideal response is then visible directly on the oscilloscope screen.

#2a CARRIER TO NOISE RATIO



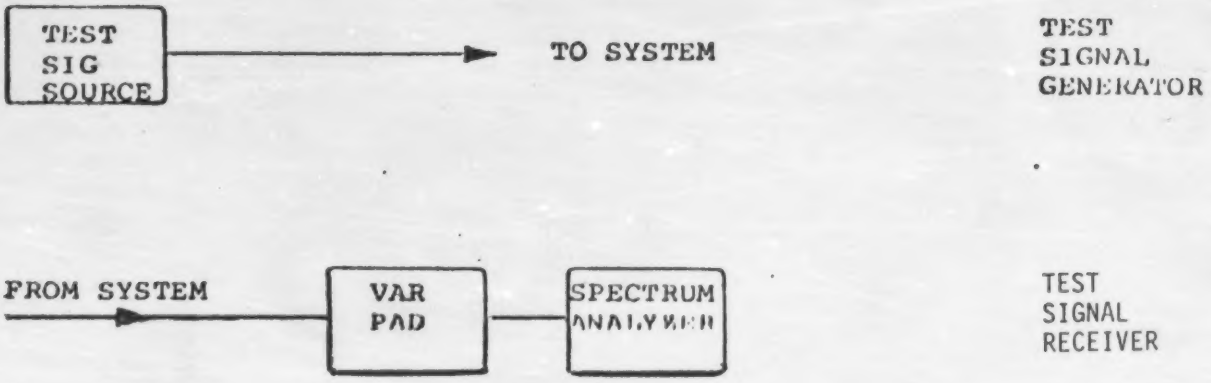
Procedure:

A Theta-Com Test Signal Source provides an unmodulated channel carrier at normal system levels on the channel under test. The FSM is tuned to the channel under test. Power to the Test Signal Source is removed leaving only pilot carriers on the system. All pads are removed from the FSM input and the FSM manual gain increased to obtain a meter deflection. The FSM is then tuned slightly each way until minimum meter deflection is observed. This eliminates the possibility that the deflection is actually off-the-air ingress into the test setup. The FSM manual gain is then readjusted to give a convenient reference system noise level reading on the meter. Power is returned to the Test Signal Source, padding is inserted, the FSM tuning is adjusted to peak once again on the carrier, and the pad is adjusted to return the meter to the noise reference level obtained earlier. (The amount of padding inserted is the uncorrected carrier-to-noise.) Four dB is then subtracted from this amount to give the carrier-to-noise ratio corrected to a 4 MHz bandwidth.

If a noise measurement calibration is available for the particular 704B, the correction may vary slightly from 4 dB. Also, this method is limited to channels 2-13 by the 704B tuning range.

If the system test point used provides insufficient level to put the system noise floor entering the 704B at least 10 dB above the 704B noise, a post amplifier may be added before the 704B to boost the system noise.

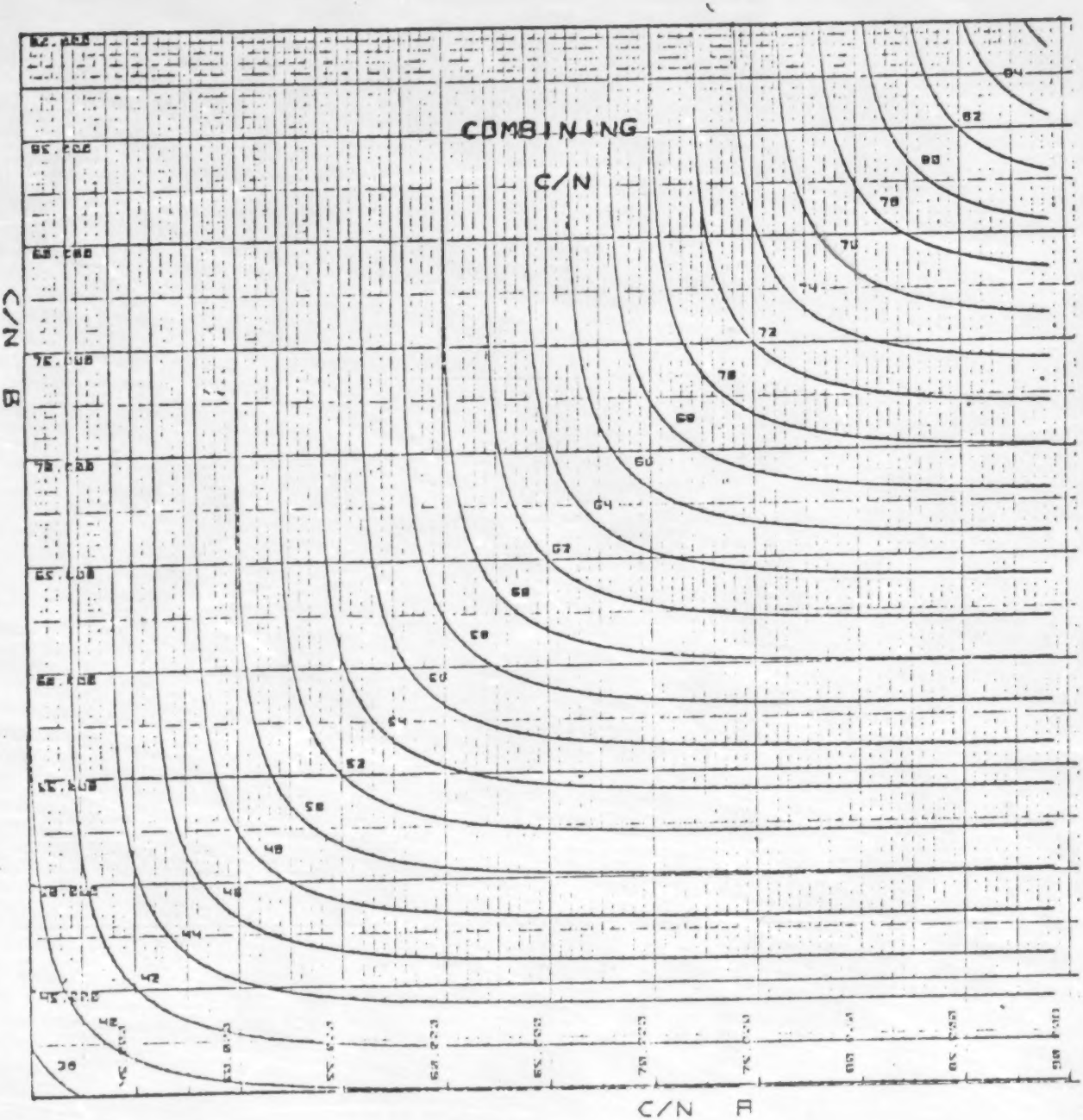
§2b CARRIER TO NOISE RATIO



Procedure:

A Theta-Com Test Signal Source provides an unmodulated channel carrier at normal system levels on the channel under test. The spectrum analyzer is operated in the 10 dB log mode with a 300 KHz bandwidth and 20 dB of external padding. The channel under test is center-tuned on the analyzer display, and the analyzer log reference level is adjusted to the level of the carrier. The 20 dB of external padding is then removed, and the log reference level is reduced 20 dB to compensate and return to the reference level. Power is then removed from the Test Signal Source. Video filtering is then added on the analyzer display and the level of the average noise below the log reference level is recorded. This is the uncorrected C/N ratio. Sixteen dB is then subtracted to obtain the corrected C/N ratio.

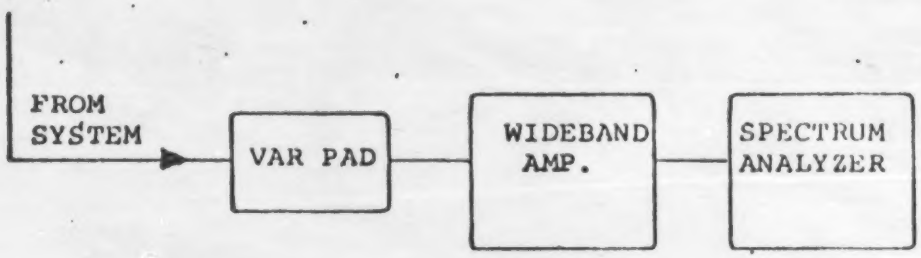
This test method requires a high level system output to get accurate measurements. If the observed noise level on the analyzer is still less than 10 dB above the noise floor of the analyzer alone, the observed C/N may be in significant error due to the noise contribution of the analyzer. A corrected reading can be obtained using the "Combining C/N" chart below.



BATTELLE - COLUMBUS

12c CARRIER TO NOISE RATIO

TEST SETUP:



Procedure:

A Theta-Com test signal source (KTSS) provides an unmodulated channel carrier at normal system levels on the channel under test. The spectrum analyzer is operated in the linear mode with a 300 KHz bandwidth as a fixed tuned receiver on the channel under test. The KTSS is then turned off. With the variable pad set at minimum (see caution below), and the video filter at 10 hz to average the noise, the analyzer i.f. gain is adjusted to give a convenient system noise floor level indication on the display (this will appear as a horizontal line). 40 dB of padding is then inserted (to protect the analyzer from overload), the KTSS power is turned on, and additional padding is inserted to return the line to the reference level. The amount of padding inserted is the uncorrected C/N of the system. To correct this to 4 MHz C/N, approximately 13 dB must be subtracted from the uncorrected C/N.

Since the test instrument noise remains at the same level throughout the test, both during the measurement of system carrier and system noise, any error introduced by test instrument noise cancels, eliminating the necessity of making correction calculations. Also, high resolution is obtained since the analyzer is operated in the linear mode.

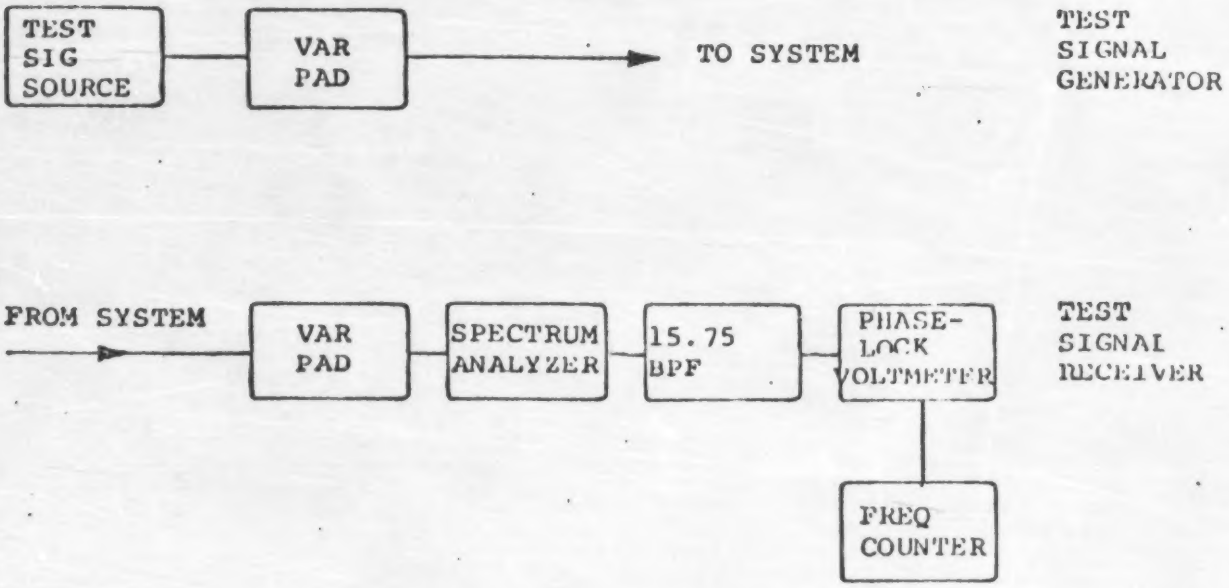
Cautions:

1. System support carriers, which are present at all times during the test, can cause compression in the test setup if levels are too high. Determine this limit by observing a pilot carrier and removing known amounts of padding to observe linearity of the test setup. Do not exceed this limit thereafter.

2. Peak the analyzer tuning on the carrier under test to be sure it is maximum.

3. Be sure that analyzer is reading system noise only, during noise measurement, by tuning slightly either way and noting that noise reference level remains unchanged.

§3 CROSS MODULATION RATIO



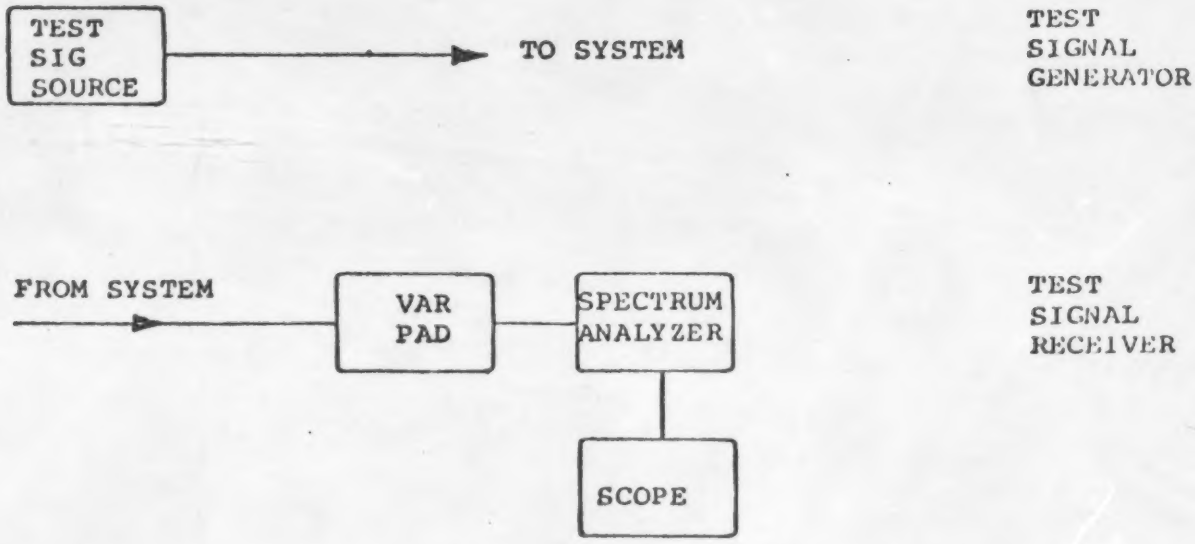
Procedure:

A Test Signal Source provides 100% square-wave synchronously-modulated carriers on all channels. The analyzer's center frequency is adjusted to the channel under test. The analyzer is then used as a receiver tuned to that channel in the linear display mode with a 100 Khz bandwidth. The analyzer I.F. gain vernier is adjusted to obtain a 100% modulation reference deflection on the voltmeter. Modulation on the channel under test is then removed and the voltmeter sensitivity increased in 10 dB steps to read the cross modulation. The frequency counter will lock on 15,750 Hz when the meter has phase-locked to the cross modulation. The level on the meter below the original reference level is then the cross modulation ratio.

In short cascades, system input levels may have to be raised to obtain enough cross modulation to be resolvable. In this case, the cross modulation ratio observed is corrected to that at normal system levels by subtracting 2 dB for each dB of elevated level.

Cross modulation can be generated in the analyzer also. To ensure that the cross modulation observed is in the system, 3 dB of pad is inserted in front of the analyzer. If the cross mod level decreases 3 dB, then all the cross mod being observed is in the CATV system. If the observed cross mod decreases more than 3 dB, pad must be added until it decreases one-for-one, and the test must be repeated.

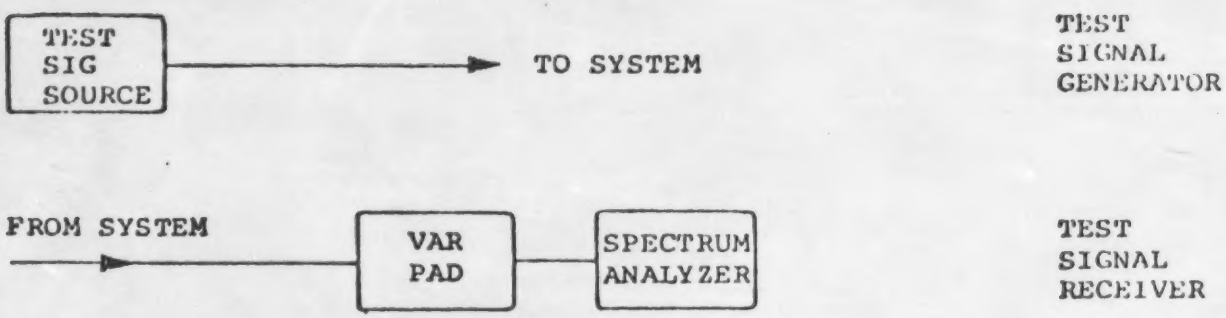
#4 HUM MODULATION



Procedure:

A Test Signal Source provides a channel carrier only on the channel under test. The spectrum analyzer is used as a fix-tuned receiver in the linear display mode with a bandwidth of 300 Khz. With 100% modulation on the channel under test, the analyzer I.F. gain vernier is adjusted to give a reference 5 division peak-to-peak display on the oscilloscope, which is ac coupled to the analyzer's vertical output. Modulation is then turned off on the channel and the oscilloscope vertical deflection sensitivity increased a fixed amount using the vertical deflection sensitivity step switch. This increases the per cent modulation per division by a known amount and the low frequency hum becomes discernible on the oscilloscope screen. A video filter on the analyzer removes the high frequency noise on the trace and allows measurement of the peak-to-peak hum modulation percentage. The percent hum modulation is then 1/2 the peak-to-peak voltage.

#5 CARRIER TO DISCRETE INTERMODULATION BEAT RATIO



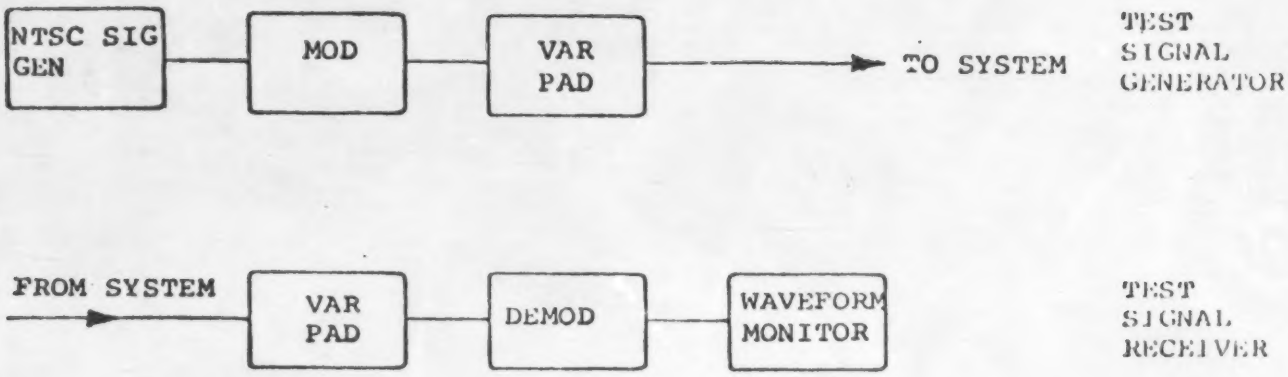
A test signal source provides unmodulated channel carriers on the channels which generate the second or third order beat of interest, and also on the channel in whose bandpass the component falls. By overdriving the analyzer front end, the desired beat is made large enough (in the analyzer) to be observed and located easily. The analyzer log ref. level is adjusted to the level of the reference carrier in the channel where the beat is to be observed. The beat is then located, and the reference channel power is turned off. The analyzer bandwidth, scan width and scan time are reduced to increase the analyzer's sensitivity. 10 dB of padding is then inserted in front of the analyzer, and the I.F. gain is increased 10 dB to compensate. This is repeated until the observed beat decreases 1 dB for each dB of pad inserted. The beat then being observed is a product of the CATV system, and is not being generated in the analyzer. Since the log ref. level has been unchanged, the relative level of the beat can be read directly from the analyzer.

To ensure that the beat being observed is the desired beat, the channel carriers producing it can be turned off one at a time in succession.

In short cascades, this test may have to be performed at elevated levels to make the beat resolvable. Suggested carriers and raised level correction factors for various system tests are listed below.

System Bandpass	Recommended test carriers & resulting Intermod Prod.	Order of Distortion	Relative Measurement derate for ea. dB of raised level
54-300 MHz	$f_{13} - f_G = f_2 - 1.25$ MHz	2nd	1 dB
	$f_9 + f_{11} - f_{12} = f_8$	3rd	2 dB
5-30 MHz	$f_{T7} + f_{T9} = f_{T10} + 1$ MHz	2nd	1 dB
5-110 MHz	$f_{T8} + f_{T9} - f_{T7} = f_{T10}$	3rd	2 dB
174-300 MHz	$f_9 + f_{11} - f_{12} = f_8$	3rd	2 dB

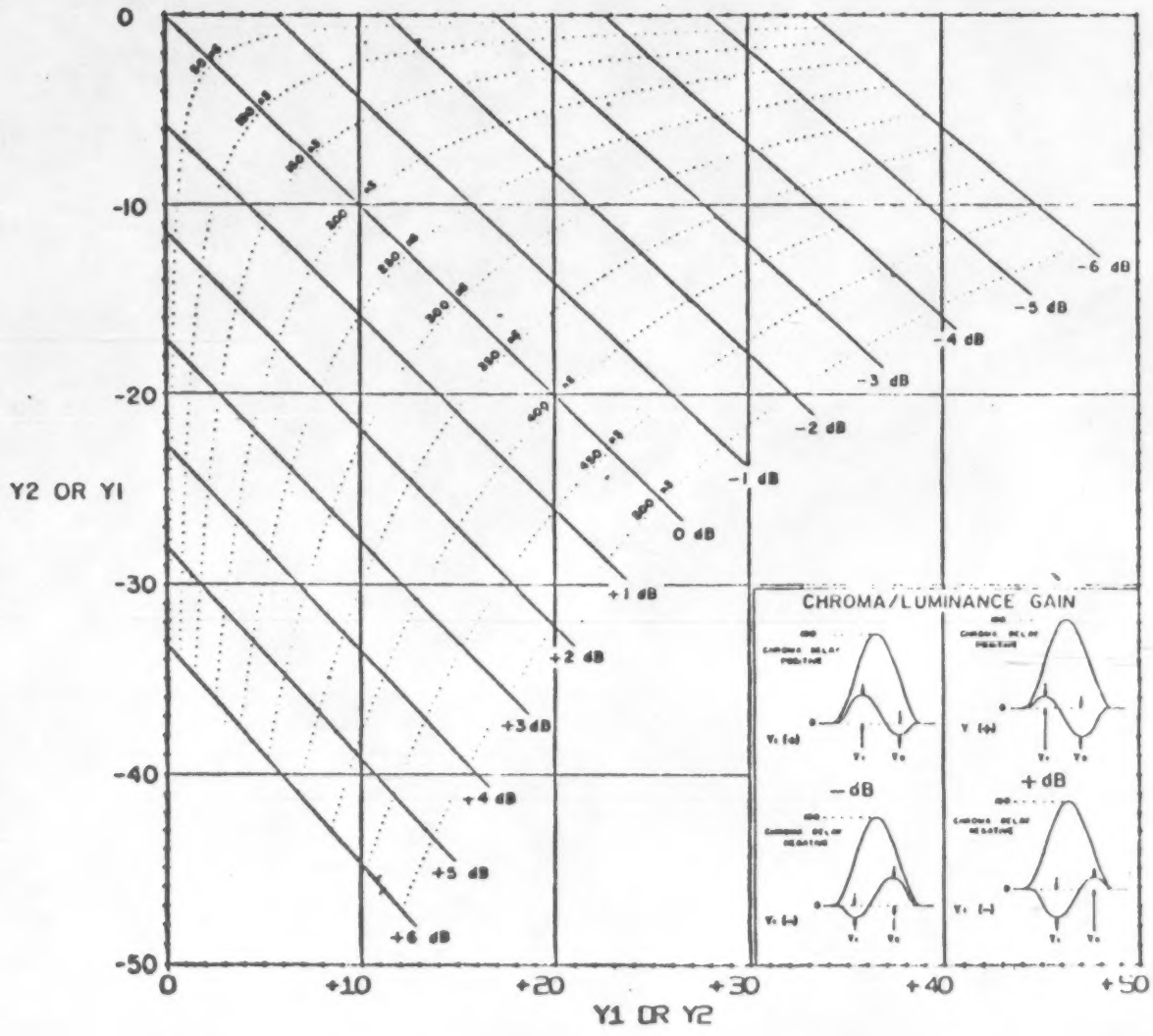
#6 CHROMA DELAY



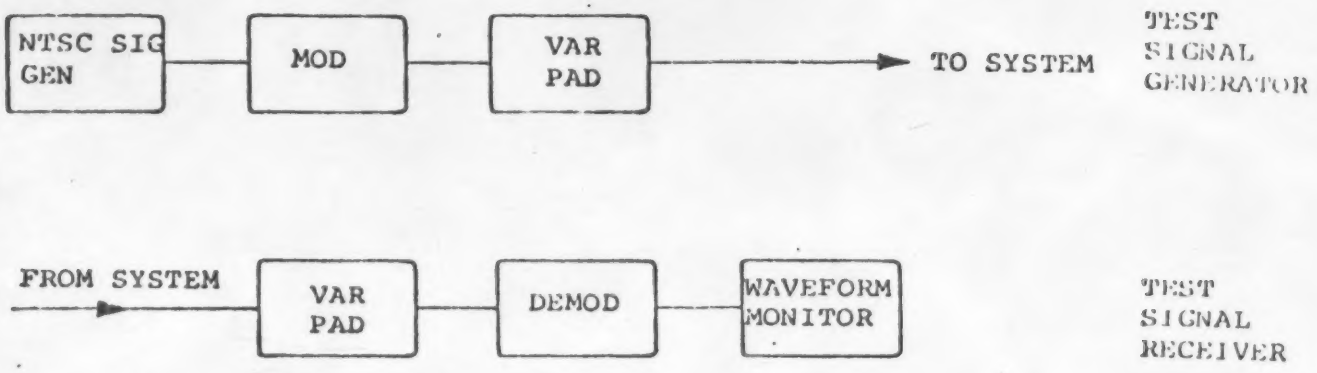
An NTSC Video Test Signal Generator supplies a video modulated carrier. The full field video line composition includes a 12.5T modulated sin pulse. Relative chrominance-to-luminance delay causes distortion of this pulse. Analysis of this distortion on a waveform monitor yields the amount of chroma delay. The displayed 12.5T pulse is adjusted to 100 IRE amplitude using the manual gain control on the waveform monitor. The amount of chroma delay is then computed using the attached nomograph.

To determine the chroma delay of the CATV system alone, the chroma delay of the modulator-demodulator pair must also be measured, and this delay subtracted algebraically from the system test results.

MODULATED SIN² PULSE APPLICATION NOMOGRAPH
12.5T 1.57 μsec h.a.d. FOR 525/60 STANDARDS



#7 ECHO RESPONSE TEST



Procedure:

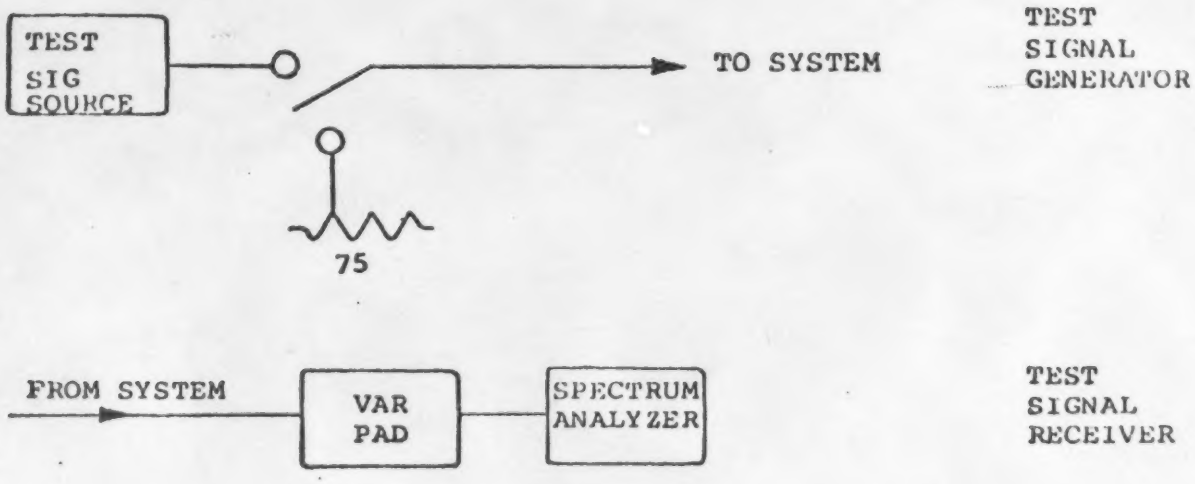
An NTSC Video Test Signal Generator supplies a video modulated carrier. The video line composition includes a 2-T pulse. Observation of the demodulated video signal on a waveform monitor at a directional tap in the CATV system with a waveform monitor will show the original 2-T pulse and, in addition, any echo(s) caused by reflection of rf energy by devices in the system.

A Mertz curve has been plotted on the waveform monitor graticule. Echoes in excess of the Mertz curve values will appear outside the plotted curve.

Care must be taken to ensure that apparent echoes are not products of pulse distortion in the modulator-demodulator pair. Prior to the test, a picture of the mod-demod pair 2-T pulse response alone should be taken for later comparison with the system data.

In extreme cascades, noise may impair this measurement. To overcome this, the carrier level of the channel under test can be increased at the headend without impairing test results.

#8a UNDESIRED SIGNAL INGRESS



Test Summary:

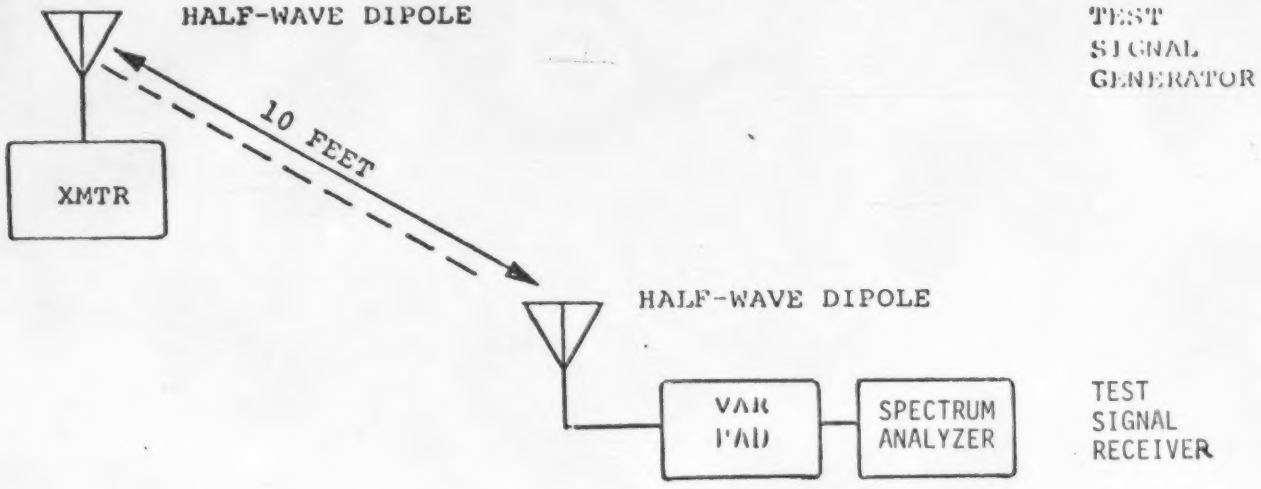
RF Spectrum Analysis is used to ensure the absence of any undesired signals which may have found their way into the CATV system. This test is performed with no signal input to the system other than that necessary to support system operation (pilot carriers and/or carriers necessary to operate composite AGC circuits).

The analyzer is used in the 10 dB log mode. Using a bandwidth sufficient to resolve at least 60 dB below normal carrier levels, the analyzer is slowly tuned across the system bandpass. Any ingress becomes readily visible. It's relative level may be determined by connecting the test signal source to provide the carrier nearest in frequency to the ingress, at the normal system operating level.

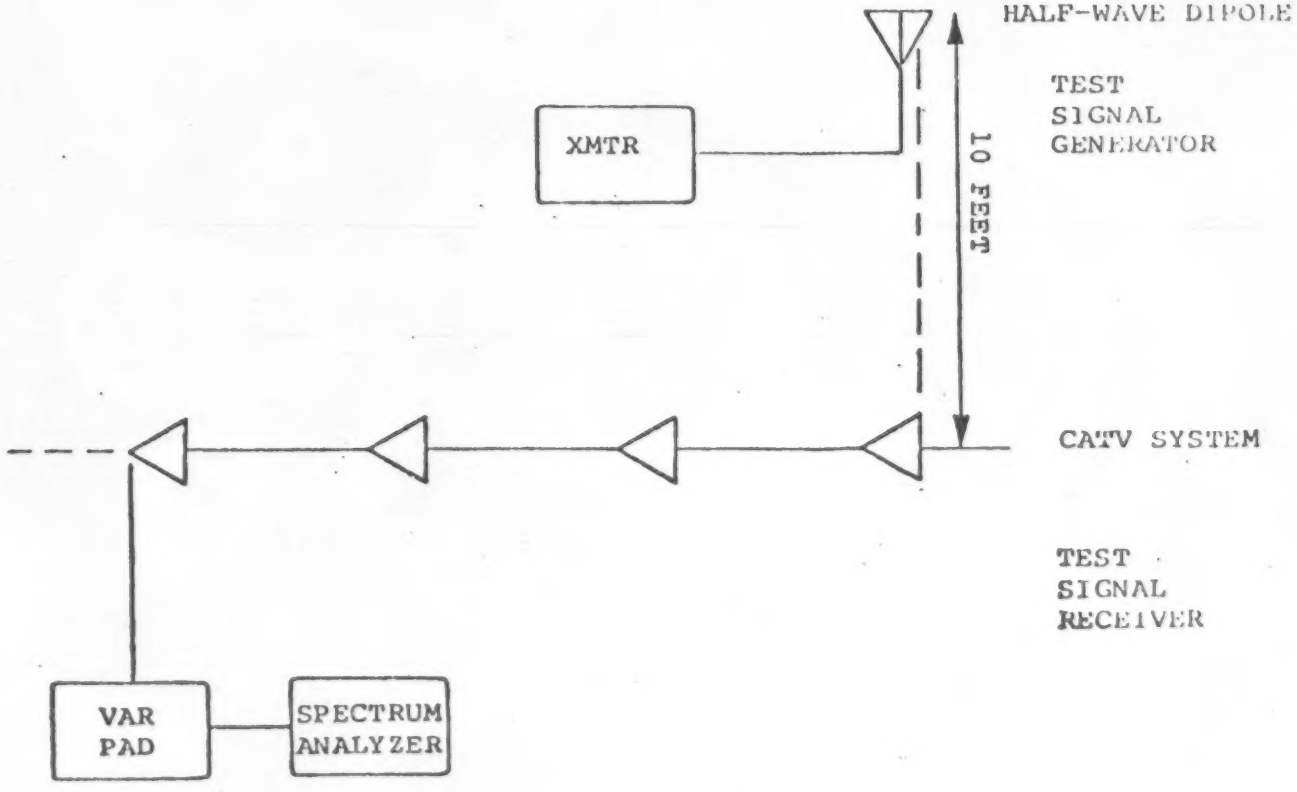
Care must be taken to ensure that observed ingress is not a product of test cables or gear. This can be done by observing the level of any ingress with the test cable terminated.

18b INGRESS IMMUNITY

Reference Field Intensity Determination Setup



System Test Setup



The Ingress Immunity test gives a quantitative measure of the CATV system's immunity to ingress from external RF fields. Ingress Immunity is defined as the carrier-to-ingress ratio in dB which results when the portion of the system under test is subjected to an rf field strength of .1 volt/meter by a half-wave dipole antenna located 12 feet off the ground and 10 feet from the system. To perform the test, a transmitter feeds a half-wave dipole antenna with a CW carrier at the frequency of interest to produce the test field. Rather than adjusting the transmitter to provide the required .1 volt/meter field strength, the actual field strength produced by the transmitter is measured and the Ingress Immunity is later corrected to that which would result from a .1 v/m field.

Procedure:

The actual field strength at 10 feet from the transmitting half-wave dipole is first determined using the Reference Field Intensity Determination Setup shown. The receiving half-wave dipole is positioned parallel to and 10 feet from the transmitting dipole. Both antennas are 12 feet off the ground. The absolute level observed on the spectrum analyzer is directly related to the corresponding field strength at the receiving antenna location by the formula.

$$E_{ref} = .005669 \text{ X Antilog } (A_{dBm}/20) \text{ X } f_{Mhz}$$

where E_{ref} = field strength at receiving antenna (v/m)

A_{dBm} = level observed on analyzer corrected for any cable loss (dBm)

f_{Mhz} = frequency (Mhz)

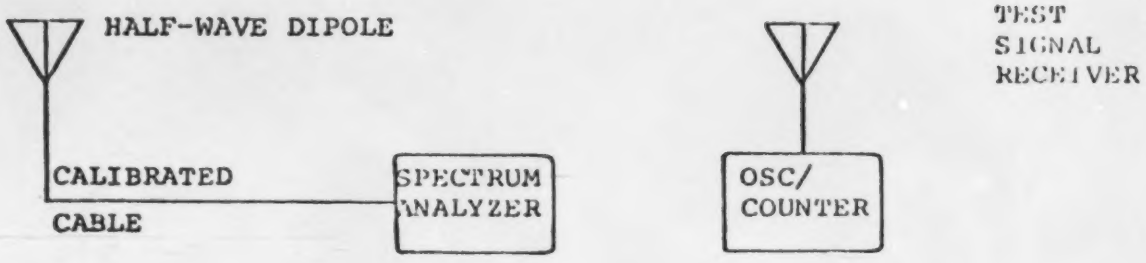
The uncorrected carrier/ingress ratio is next determined using the System Test Setup shown. The transmitting dipole is positioned 12 feet off the ground and 10 feet from and parallel to the system. The portion of the system directly opposite the antenna is then immersed in the reference rf field, and any ingress into the system will be observable anywhere down that cascade. To eliminate the possibility of direct pickup of the test signal by the test equipment, the test receiver should be located several amplifiers down the cascade. The level of the observed ingress relative to normal operating level of the nearest channel carrier is the uncorrected carrier-to-ingress ratio.

To correct from E_{ref} to the standard .1 volt/meter field, $20(\text{Log}(E_{ref})+1)$ dB must be algebraically added to the uncorrected carrier/ingress ratio. The result is the Ingress Immunity, in dB, of the tested system.

CAUTION:

An external pad is recommended in front of the analyzer since signal levels observed may exceed the analyzer's recommended input level limits.

#9 RADIATION



Test Summary:

To ensure that any radiation observed is originating from the CATV system, carrier frequencies not likely to be found off the air are chosen. Most suitable for the test are system pilot carrier frequencies.

The oscillator is tuned to the frequency of the radiating carrier to be observed. The oscillator amplitude is then increased until the oscillator radiates sufficiently through an antenna connected to its output (a short wire will suffice) to be observable on the wide band analyzer display. The analyzer scan width, bandwidth, and scan time are reduced to increase the analyzer sensitivity. When the sensitivity has been increased sufficiently; a second, low level spur will be noted on the display near the known frequency reference. This is the CATV system radiation. The level, in dBmV, of the displayed radiation can be read directly from the analyzer. This observed level is then related to the radiated field strength by

$$E = 5669 \times F \times 10^{\left(\frac{A}{20}\right)}$$

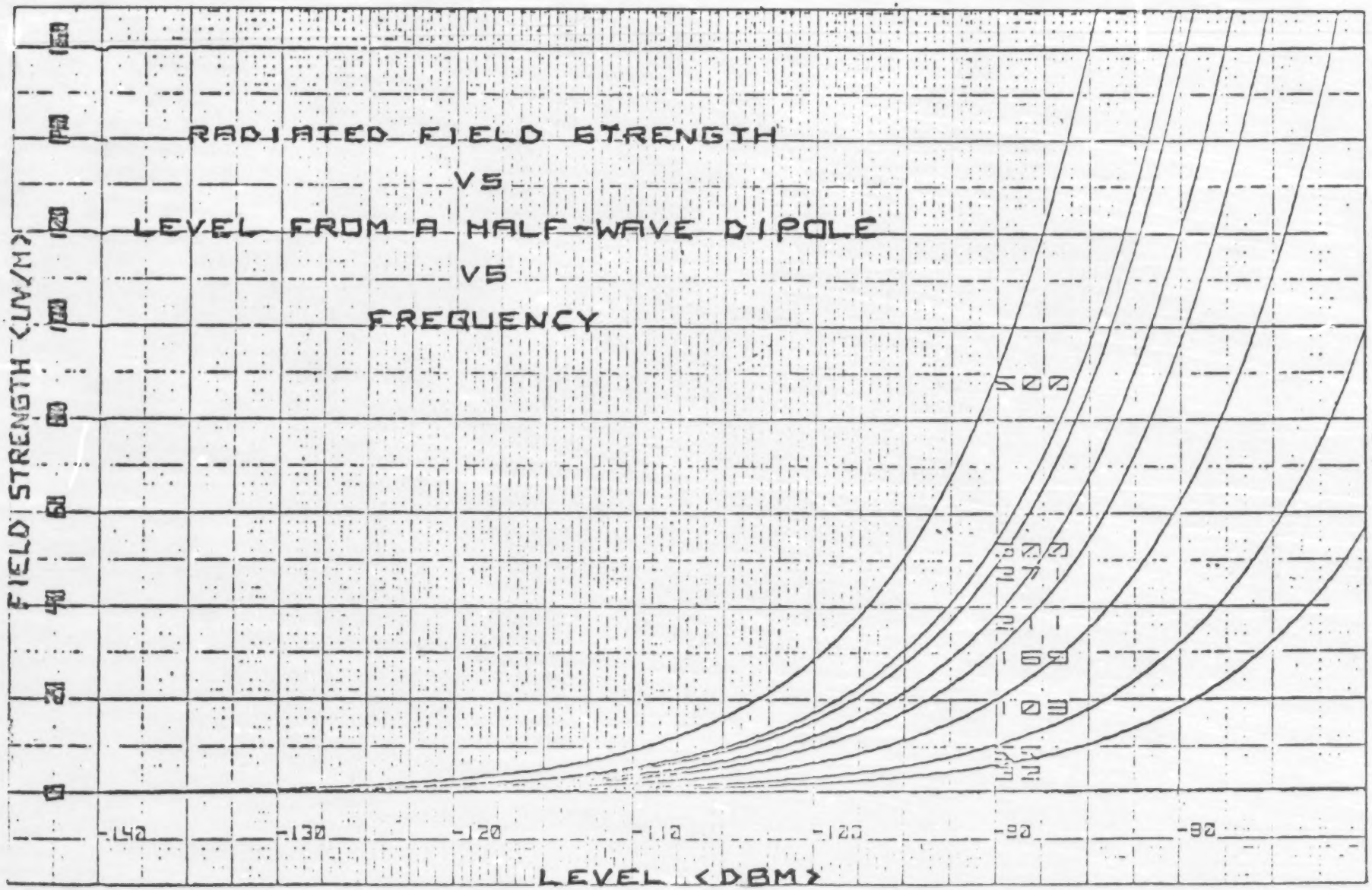
Where E = radiated field strength in μv/m

F = frequency of radiation in MHz

A = amplitude of observed radiation in dBm, corrected for cable loss

For convenience, this formula has been plotted on the attached sheet for some popular pilot carrier frequencies.

For proper results, the dipole must be held 10 feet from the CATV system and 12 feet off the ground.


RADIATED FIELD STRENGTH
VS
LEVEL FROM A HALF-WAVE DIPOLE
VS
FREQUENCY
FIELD STRENGTH <UV/M>
LEVEL <DBM>
-140
-130
-120
-110
-100
-90
-80
200
150
100
60
30
15

B-48